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Transient Cycle Arrangement for Heavy-Duty Engine and Chassis Emission Testing

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Transient Cycle Arrangement for Heavy-Duty Engine and Chassis Emission Testing

by

Chester J. France

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16. ABSTRACT

Olson Laboratories, EPA's heavy-duty cycle development contractor, has generated various nominal 5-minute chassis and engine cycles from the CAPE-21 data base. The Emission Control Technology Division of EPA has in turn, selected the best cycle in each category for which cycles were generated (both chassis and engine cycles). The final step in ECTD's HD transient cycle development effort is the arrangement of these five minute cycles into one cycle which exhibits the proper trip characteristics as determined from the CAPE-21 survey data.

The purpose of this report is to identify the cycle arrangement that has the proper trip characteristics and which also meets certain practical requirements. Chassis and engine cycle arrangements for both HD gasoline and diesel vehicles are developed. The equations necessary for exhaust emission calculations are also presented.

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Foreward

Olson Laboratories, EPA's heavy-duty (HD) cycle development contractor, has generated various nominal 5-minute chassis and engine cycles from the CAPE-21 data base.* The Emission Control Technology Division (ECTD) of EPA has in turn, selected the best cycle in each category for which cycles were generated (both chassis and engine cycles).** The final step in ECTD's HD transient cycle development effort is the arrangement of these five minute cycles into one cycle which exhibits the proper trip characteristics as determined from the CAPE-21 survey data.

The purpose of this report is to identify the cycle arrangement that has the proper trip characteristics and which also meets certain practical requirements. Chassis and engine cycle arrangements for both HD gasoline and diesel vehicles are developed. The equations necessary for exhaust emission calculations are also presented.

* "Heavy-Duty Vehicle Cycle Development," EPA Draft Final Report, July 1978 (to be released about September 1978).

** "Selection of Transient Cycle for Heavy-Duty Engines," EPA Technical Report HDV 77-01, by T. Wysor and C. France, November 1977 and "Selection of Transient Cycles for Heavy-Duty Vehicles," EPA Techical Report HDV 78-02, by T. Wysor and C. France, June 1978.

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I. Summary

Objective

The objective of this report is to develop a cycle arrangement that has the proper trip characteristics (e.g., non-freeway/freeway weighting; city weighting; hot operation/cold operation weighting; and trip length) and also meets requirements dictated by program needs and practical considerations. Chassis and engine cycle arrangements including corresponding emission calculation equations for both heavy-duty gasoline and diesel vehicles will also be derived.

Results

Various nominal 5-minute chassis and engine cycles (developed by EPA's cycle development contractor, Olson Laboratories) were arranged into one cycle (one for chassis and one for engine) that exhibited the proper heavy-duty trip characteristics. The trip characteristics were determined from the CAPE-21 survey data.

Several other practical constraints (summarized in section III(A) "Practical Requirements Governing Cycle Arrangement") also influence the arrangement of the finalized cycles.

The finalized engine and chassis cycle arrangements are shown below.

Finalized Engine Cycles

Segment No:	1 New York Non-freeway	2 Los Angeles Non-freeway	3 Los Angeles Freeway	4 New York Non-freeway
Gasoline:	272 sec.	307 sec.	316 sec.	272 sec.
Diesel:	297 sec.	300 sec.	305 sec.	297 sec.

20 minute nominal trip length
(actual trip length = 19.45 min. for gasoline
and 19.98 min. for diesel)

Finalized Chassis Cycle
(Gasoline and Diesel)

Segment No:	1 New York Non-freeway	2 Los Angeles Non-freeway	3 Los Angeles Freeway	4 New York Non-freeway
	254 sec.	285 sec.	267 sec.	254 sec.

20 minute nominal trip length
(actual trip length = 17.67 min.)

A complete emission test would consist of a cold start and a hot start cycle run. (The second-by-second listings for these cycles can be found in Appendices II and III.)

The corresponding equations for emission calculation are:

1) engine cycle:

$$A_{wm} = \frac{1/7(g_c) + 6/7(g_h)}{1/7(BHP\text{-}Hr_c) + 6/7(BHP\text{-}Hr_h)}$$

Where:

A_{wm} = Weighted mass emission level (HC, CO, CO_2, or NOx) in grams per brake horsepower-hour.

g_c = Mass emission level in grams, measured during the cold start test.

g_h = Mass emission level in grams, measured during the hot start test.

$BHP\text{-}Hr_c$ = Total brake horsepower-hour (brake horsepower integrated with respect to time) for the cold start test.

$BHP\text{-}Hr_h$ = Total brake horsepower-hour (brake horsepower integrated with respect to time) for the hot start test.

and

2) chassis cycle:

$$A_{wm} = \frac{1/7(g_c) + 6/7(g_h)}{5.55}$$

Where:

A_{wm} = Weighted mass emission level (HC, CO, CO_2, or NOx) in grams per vehicle mile.

g_c = Mass emission level in grams, measured during the cold start test.

g_h = Mass emission level in grams, measured during the hot start test.

Conclusions

The cycle arrangement above was fundamentally based on the CAPE-21 data base and the cycles generated from it. In some cases engineering judgement was relied upon. The finalized composite cycles exhibit trip characteristics supported by the CAPE-21 data base and can be considered representative of an urban trip for a HD truck.

II. Introduction and Background

The initial step in ECTD's cycle development effort was the collection of urban truck operational data. The CAPE-21 project* accomplished this task. In the CAPE-21 survey forty-four (44) trucks and three (3) buses were surveyed in Los Angeles (LA), and forty-four (44) trucks and four (4) buses were surveyed in New York City (NY). Speed (mph), engine rpm, engine power, engine temperature, and various road and traffic descriptions were recorded on tape at approximately one second intervals. The vehicles performed their normal daily functions while these data were collected.

From this data base, Olson Laboratories generated numerous 5-minute (approximate) long transient cycles using the Monte Carlo technique.** ECTD selected, from the cycles delivered, the best cycle in each category. The selected cycles and their identification numbers are listed below.

Engine Cycles Selected

Identification Number	Cycle Description
203887989	LA Non-Freeway, Gasoline
296644805	LA Freeway, Gasoline
8410263	NY Non-Freeway, Gasoline
792043535	NY Freeway, Gasoline
2110248101	LA Non-Freeway, Diesel
1599345415	LA Freeway, Diesel
2114147447	NY Non-Freeway, Diesel
104099549	NY Freeway, Diesel

*"Truck Driving Pattern and Use Survey, Phase II - Part I," Final Report, EPA Report No. EPA-460/3-77-009, June 1977 and "Truck Driving Pattern and Use Survey, PhaseII - Part II," EPA Technical Report HDV 78-03, by Leroy Higdon, May 1978.

** "Heavy-Duty Vehicle Cycle Development," EPA Draft Final Report, July 1978 (to be released about September 1978).

Chassis Cycles Selected

Identification Number	Cycle Description
2106204593	LA Non-Freeway, Gasoline and Diesel
1539135071	LA Freeway, Gasoline and Diesel
2120127413	NY Non-Freeway, Gasoline and Diesel
2037082365	NY Freeway, Gasoline and Diesel

The procedures used to select these cycles are described in the EPA reports "Selection of Transient Cycles for Heavy-Duty Engines," (HDV 77-01) by T. Wysor and C. France, November 1977, and "Selection of Transient Cycles for Heavy-Duty Vehicles," (HDV 78-02) by T. Wysor and C. France, June 1978.

The remaining task in the HD cycle development effort is the logical arrangement of the above cycles into one cycle for chassis testing and one for engine testing. The following text will address this topic. The discussion is structured into four major sections. They are: A) practical requirements governing cycle arrangement, B) pertinent cycle characteristics, C) finalized cycles and corresponding emission calculation equations, and D) conclusions.

III. Discussion

A. Practical Requirements Governing Cycle Arrangement

Below are listed several requirements dictated by program needs and practical considerations to which the test cycles should conform.

1) Nominal length (time) of the engine cycle and chassis cycle should be the same. The cycle length for both types of cycles logically should be the same since they were generated from the same data base.

2) New York and Los Angeles operation should be given equal weighting in the finalized cycles. ECTD presently does not have any information or data that indicates whether New York or Los Angeles operation is more typical of HD urban operation. Fifty-fifty weighting of each city is the only alternative at this time.

3) The non-freeway and freeway operation should receive the same proportional weighting as in the CAPE-21 data base.

4) The chassis cycle used for HD evaporative emission testing should be the same as that used for exhaust emission testing.

5) The same test cycle should be used for diesel particulate testing and diesel gaseous emission testing.

6) The diesel particulate test cycle must be inherently weighted. The diesel particulate test requires a long sample period (greater than 15 minutes) to insure accurate results. This requirement dictates a cycle that inherently weights the freeway and non-freeway operation, and city weighting. If this was not the case, emissions measured over a cycle segment (e.g. LA non-freeway) would have to be weighted properly and then summed with the other cycle segment results. However, 5 minutes (the typical segment length) is insufficient measurement time for particulate testing.

7) The emission test cycle should include both cold and hot start cycles. This requirement insures an accurate assessment of cold start emissions. This is particularly important should HD gasoline engines be equipped with catalyst emission control systems.

B. Pertinent Cycle Characteristics

1) Trip Length.

The major concern of trip length is its influence on hot versus cold emissions. As a trip becomes longer, there is less influence on average emissions by the cold start portion of the trip. This is of more concern for gasoline engines than for diesel engines, and becomes very important if catalyst control systems are used. The following discussion addresses the issue of trip length.

Table 1 lists the trip summary data from the CAPE-21 survey.

Table 1

Time per Trip*
(in minutes)

Category	Total No. of Trips	Mean	Median	Standard Deviation	Range
LA Gas	931	19.31	12.22	21.17	0-180
NY Gas	995	19.30	7.97	38.39	0-440
LA Diesel	313	38.82	27.40	45.06	0-330
NY Diesel	234	55.23	25.50	79.88	0-460

* A trip is defined as engine-on to engine-off.

It should be pointed out that the reason there are such large differences between the means and medians is that the density functions are not normally distributed (see Figures 1 and 2). Instead the density functions follow a Weibull density function or even an exponential density function quite well. This fact supports the use of the median as a measure of central tendency. The means would be abnormally weighted by the extreme values and therefore misleading.

Using a purely statistical approach the following median trip lengths are appropriate.

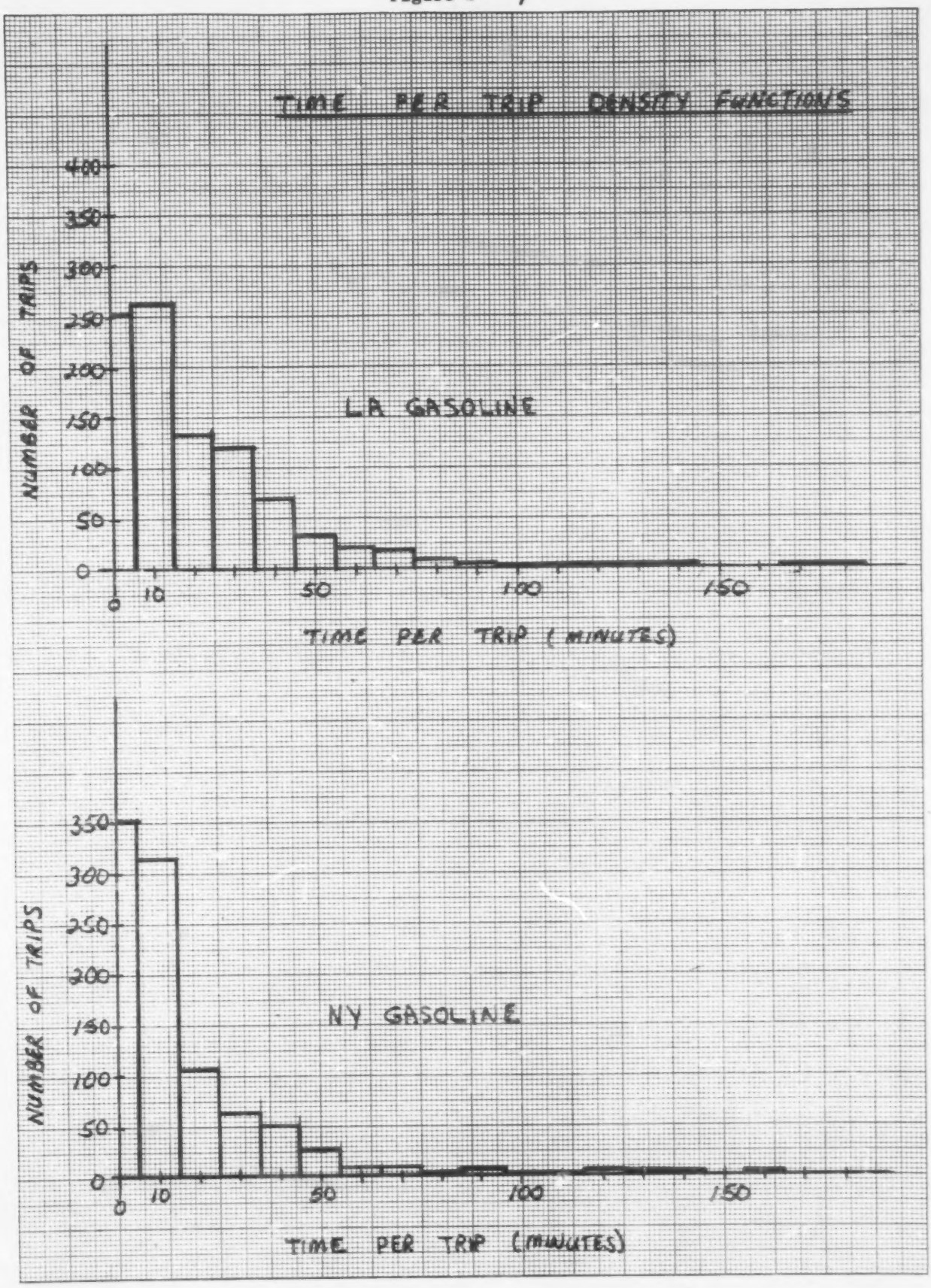
Category	Median Trip Length
LA Gas	12 minutes
NY Gas	8
LA Diesel	27
NY Diesel	26

However, considering the range of the trip lengths and noting the shape of the distribution functions (see Figures 1 and 2) any trip length from about 10 to 25 minutes for gasoline vehicles and 20 to 50 minutes for diesel vehicles appears reasonable. The large standard deviations (21 to 80 minutes) also demonstrate that the trip statistics above are imprecise.

A twenty minute trip seems very appropriate for gasoline engines. This would be a "nominal" trip length. The actual trip length would be a function of which set of cycle segments (e.g., NY non-freeway, LA non-freeway, etc.) are ultimately selected and may differ slightly for engine and chassis cycles. In any case the actual cycle time will be approximately 20 minutes.

A twenty minute trip length was also selected for diesel engines even though it is a little short. The consequence of such a short cycle is that cold start emissions will be overweighted. It is anticipated at this time that this will not pose a problem. The relative difference between cold and stabilized emissions from diesel engines should not be great enough for this overweighting to be critical. If this judgment proves to be incorrect, two options will be available. One would be to run the twenty minute cycle twice, back to back, to obtain a 40 minute cycle. The practical aspects of doubling the test time (cost, instrument durability, increased probability of void tests, etc.) would be more detrimental than the advantages that might be gained. The other option would be to compensate by an appropriate adjustment to the cold trip and hot trip weighting factors.

Figure 1 7



10 X 10 TO THE CENTIMETER. 18 X 25 CM.
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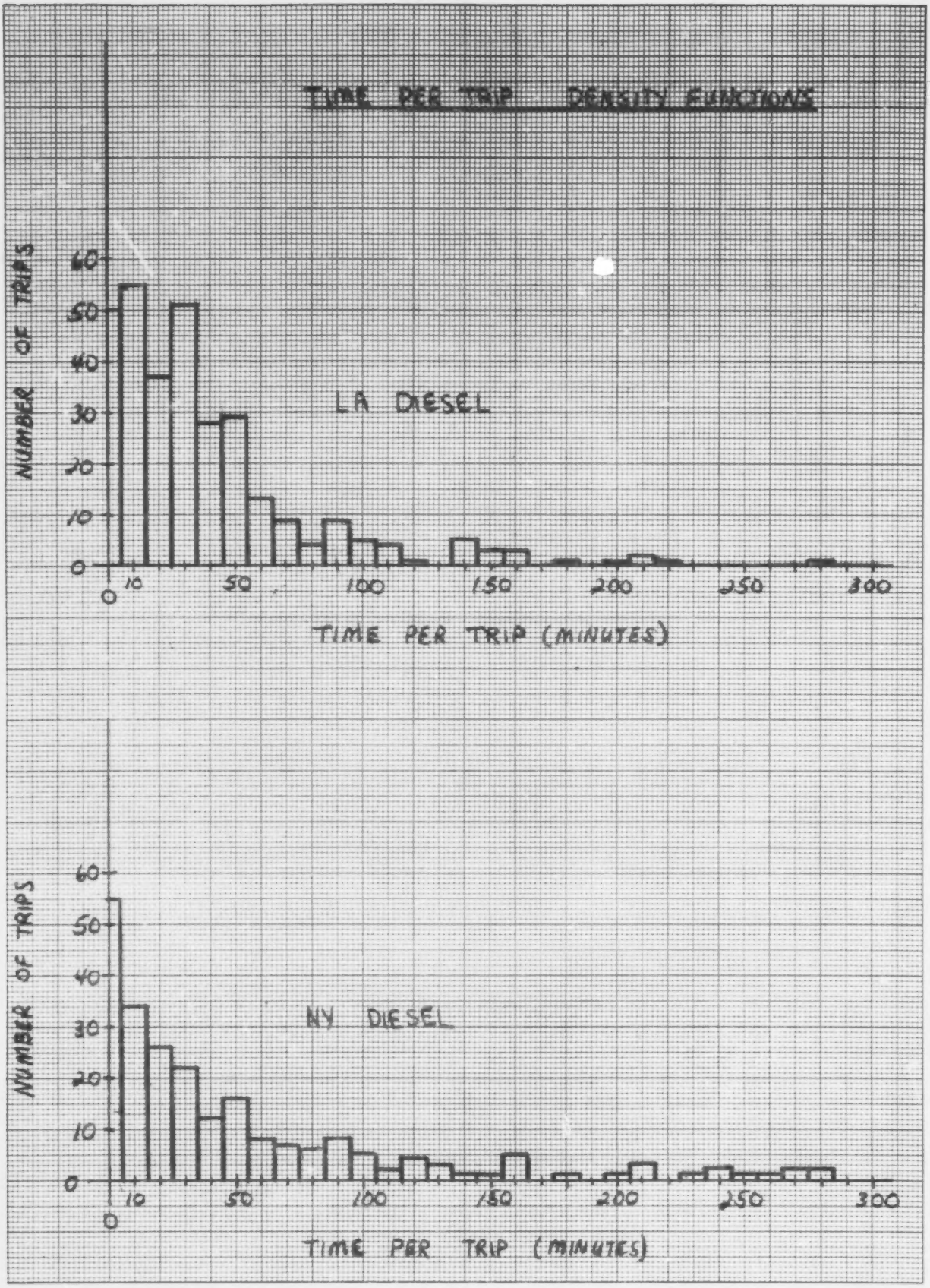
Figure 2



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As will be seen later, the number of trips per day of gasoline vehicles versus diesel vehicles also effects cold start weighting. The hot/cold trip weighting factors seleted under section B(3) underweight the cold start emissions for diesels. This underweighting will tend to offset the overweighting resulting from a 20 minute trip length.

2) Selection of Cold Start Segment

Based on a hot/cold analysis* of the CAPE-21 data it was concluded that there was not a significant difference in hot versus cold truck operation from a practical viewpoint. Therefore, a separate cold start cycle was not generated from the CAPE-21 data base. The analysis does show that a cold start was characterized by a longer than normal initial idle period. Table 2 summarizes the initial idle time following cold, warm, normal, and hot starts.

Table 2 suggests a median initial idle time of 24 seconds for gasoline trucks (LA and NY). Table 2 also indicates that diesel trucks have a typical initial idle period of 12 seconds (median value). It should be noticed that there is a drastic difference between the median values for LA diesels and NY diesels (.67 min. versus .02 min.). Because the initial idle is extremely short for NY diesels when compared to the other categories, the NY diesel truck data are suspicious. The initial idle time summary statistics may not be that reliable for the NY diesel due to the limited number of trucks that were used in the hot/cold analysis from which Table 2 was derived. The initial idle period for the LA diesels are of the same order of magnitude as the LA and NY gas trucks and does appear to be reasonable.

The practicalities of running the transient test procedure prevent the initial idle period following a cold start from getting much shorter than 24 seconds. Sufficient idle time is necessary to allow the engine to stabilize with the proper choke setting (after starting) and to enable the engine dynamometer to be placed in the transient control mode. Since the initial idle period for the NY diesels is somewhat suspicious and because diesels are less sensitive to cold start characteristics than gasoline engines the initial idle for gasoline engines will also be used for diesel engines.

It should be emphasized that the initial idle summary statistics (presented in Table 2) are highly variable. Large differences exist between the medians and means due to the skewed distributions. The extreme values (long idle periods) for some trucks excessively weight the means. This fact also contributes to the large standard

*"Analysis of Hot/Cold Cycle Requirements for Heavy-Duty Vehicles," EPA Technical Report HDV 78-05, by Chester France, June 1978.

Table 2

Initial Idle Time
(in minutes)

(An asterisk indicates a frequency of one or less)

	Trip Type															
	Cold Start			N	Warm Start			N	Normal Start			N	Hot Start			N
	Mean	Median	Std. Dev.		Mean	Median	Std. Dev.		Mean	Median	Std. Dev.		Mean	Median	Std. Dev.	
LA GAS:	1.56	0.43	2.44	17	0.56	0.37	0.71	11	0.34	0.10	0.63	39	0.18	0.10	0.27	88
NY GAS:	1.78	0.23	2.69	10	0.86	0.35	1.23	4	1.25	0.20	3.00	22	0.44	0.10	1.20	62
LA DIESEL:	2.85	0.67	4.19	15	0.40	0.10	0.57	19	0.26	0.13	0.32	26	*	*	*	0
NY DIESEL:	0.05	0.02	0.08	6	0.20	0.10	0.23	3	0.34	0.13	0.33	9	*	*	*	1
All LA Trucks:	2.17	0.47	3.38	32	0.46	0.25	0.62	30	0.31	0.10	0.53	65	0.18	0.10	0.27	88
All NY Trucks:	1.13	0.03	2.25	16	0.58	0.27	0.95	7	0.98	0.20	2.55	31	0.43	0.10	1.19	63
All GAS:	1.64	0.40	2.48	27	0.64	0.37	0.84	15	0.67	0.17	1.90	61	0.28	0.10	0.80	150
All DIESEL:	2.05	0.20	3.74	21	0.37	0.10	0.53	22	0.28	0.13	0.32	35	*	*	*	1
All Trucks:	1.82	0.30	3.07	48	0.48	0.27	0.68	37	0.53	0.15	1.53	96	0.28	0.10	0.80	151

deviations. Even among the statistics (e.g., medians) there are wide ranges of values (1 to 40 seconds for medians) among the various truck categories. The median was used to eliminate excessive weighting by extremely long initial idle periods. It was also thought to best represent the most typical initial idle time for the CAPE-21 trucks, moreso than the means. Arguments could be constructed for longer initial idle periods than the one selected above, however any idle time less than the one selected would be difficult to justify (at least for gasoline vehicles).

In summation, a 24 second initial idle time was selected for both gasoline and diesel engine cycles. The same 24 second initial idle time was also placed at the beginning of the opening segment of the chassis cycle.

Only one cycle segment is really a logical choice for the opening segment. The segment is New York, non-freeway. The reasons for this are: (1) this segment, by far, contains the most idle (greater than 40%) and (2) its statistics (mean mph, mean % power, mean % rpm, and % idle) are more characteristic of cold operation than those of the other cycle segments.*

To simply add the required idle to the front of the New York cycle would artificially inflate the total cycle's percent idle. A much better approach would be to reorder the idle in the New York non-freeway segment. Reordering the idle does not alter the representativeness of the cycle and is a statistically valid maneuver.

The reordered New York non-freeway segments can be found in Appendix I. (The unmodified versions can be found in EPA Technical reports HDV 77-01 and HDV 78-02.) Both the engine (gasoline and diesel) and chassis cycles are listed.

3) Hot/Cold Weighting Factors

One of the requirements (listed earlier) governing the cycle arrangement is a cold and hot start test. Because of this requirement the appropriate hot/cold weighting factors need determination. The number of trips per day and the number of cold starts per day for LA and NY trucks are necessary information for calculation of the weighting factors.

Table 3 summarizes the trips per day for various CAPE-21 truck categories. The only categories of real interest in this table are LA trucks (gas and diesel) and NY trucks (gas and diesel). As before, the median values are more appropriate because of non-normalities. The median trips per day for both the LA and NY trucks is seven (7).

*"Analysis of Hot/Cold Cycle Requirements for Heavy-Duty Vehicles," EPA Technical Report HDV 78-05, by Chester France, June 1978.

Table 3

Trips per Day

Truck Category	Sample Size	Mean	Median	Standard Deviation
LA 2-axle GAS	71	10.28	8.10	6.03
LA 3-axle GAS	4	11.75	12.00	2.28
LA TT GAS	18	8.56	5.83	5.19
LA 2-axle DSL	2	14.50	11.00	3.50
LA 3-axle DSL	19	6.84	5.83	3.41
LA TT DSL	24	6.42	5.75	2.58
LA all GAS	93	10.01	7.83	5.82
LA all DSL	45	6.96	5.93	3.42
LA All Trucks	138	9.01	7.17	5.35
LA Buses	7	7.43	5.88	1.84
NY 2-axle GAS	76	12.14	11.00	8.62
NY 3-axle GAS	2	6.50	1.00	5.50
NY TT GAS	9	6.56	4.50	5.23
NY 2-axle DSL	5	2.80	2.25	0.75
NY 3-axle DSL	16	3.44	1.86	3.10
NY TT DSL	24	6.88	5.00	5.09
NY all GAS	87	11.44	10.38	8.48
NY all DSL	45	5.20	2.92	4.53
NY All Trucks	132	9.31	7.00	7.95
NY Buses	13	11.62	9.50	7.12

Table 4

Time Between Trips
(in minutes)

All Days:	Sample Size	Mean	Median	Standard Deviation
LA 2-axle GAS	659	21.24	12.54	25.88
LA 3-axle GAS	43	20.98	14.25	20.95
LA TT GAS	136	35.34	23.50	42.20
LA 2-axle DSL	27	21.15	12.00	26.30
LA 3-axle DSL	111	33.86	22.85	37.98
LA TT DSL	130	28.56	21.83	27.42
LA all GAS	838	23.51	14.18	29.42
LA all DSL	268	30.01	19.50	32.35
LA All Trucks	1106	25.09	15.53	30.28
LA Buses	45	19.87	14.00	15.81
NY 2-axle GAS	847	17.65	10.17	27.76
NY 3-axle GAS	11	21.18	18.00	13.77
NY TT GAS	50	25.56	20.50	24.39
NY 2-axle DSL	9	17.00	14.75	6.04
NY 3-axle DSL	39	43.24	15.25	63.42
NY TT DSL	141	25.99	17.60	31.78
NY all GAS	908	18.13	10.48	27.52
NY all DSL	189	29.12	16.86	40.51
NY All Trucks	1097	20.02	11.07	30.44
NY Buses	138	10.19	5.55	19.28

To determine the number of cold start trips per day refer to Table 4. This table lists the time between trips for various CAPE-21 truck categories. The times between trips listed are the engine-off times between trips. The engine-off time preceding the first start of the day was not included in the calculation of these summary statistics. The median values (and mean values for that matter) clearly demonstrate that only the first start of the day can be considered cold. Therefore, the remaining trips can be considered hot starts.

Based on the above information the appropriate hot and cold weighting factors are shown below.

$$\text{Cold Start Weighting Factor} = \frac{\text{Number of Cold Start Trips per Day}}{\text{Total Number of Trips per Day}} = \frac{1}{7}$$

$$\text{Hot Start Weighting Factor} = \frac{\text{Number of Cold Start Trips per Day}}{\text{Total Number of Trips per Day}} = \frac{6}{7}$$

4) Hot Soak Time

Again because of a cold start and hot start test requirement, the proper hot soak time has to be assessed. Table 4 will provide the necessary information.

The summary statistics in Table 4 exhibit the same degree of variability as the time per trip data listed earlier. The density functions are not normal and the standard deviations are huge. Noting this large amount of variation among the trucks, a 20 minute hot soak time seems entirely reasonable. The actual median values do indicate a hot soak time of eleven (11) to sixteen (16) minutes. A hot soak time of 20 minutes is close to these values when compared to the wide range of values. Also, practical considerations of running the test (e.g., sampling bag evacuation, dynamometer and computer pre-test preparation, etc.) discourage the use of a shorter soak time.

C. Finalized Cycles and Corresponding Emission Calculations

1) Finalized Engine Cycles

There is no strong basis for ordering the remainder of the segments after the cold start segment. The only related constraint is the proper non-freeway (N-F) and freeway (F) weighting. The N-F/F weighting factors for the CAPE-21 data base are shown below.

Table 5

CAPE-21 Non-Freeway and Freeway Weighting

Category	Non-Freeway	Freeway
LA Gas	.30	.20
NY Gas	.44	.06
LA Diesel	.24	.26
NY Diesel	.41	.10

A complicating factor in trying to duplicate the weightings above, is that all cycles (engine and chassis) generated are a nominal five minutes in length. It is impossible using the five minute cycles, the 20 minute trip length, and a 50/50 city weighting, to exactly match the N-F/F weighting in Table 5.

The best compromise is to simply delete the New York freeway cycle. This cycle only represents 6% of the data for gasoline and 10% of the data for diesel. Also, the New York freeway cycle for gasoline engines was tainted by questionable RPM data from New York gas truck 09.* Consequently, the cycle's representativeness is debatable. The New York non-freeway gasoline engine cycle was influenced substantially less by truck 09 and it is felt that the cycle remains reasonably representative. The deletion of the New York freeway cycle eliminates most of the potential influence of truck 09 on the finalized gasoline engine cycle. To maintain the proper city weighting the NY N-F cycle could be run twice. The resulting cycle would look like this:

Figure 3

Finalized Engine Cycle

Segment No:	1	2	3	4
	NY N-F	LA N-F	LA F	NY N-F
Gas:	272 sec.	307 sec.	316 sec.	272 sec.
Diesel:	297 sec.	300 sec.	305 sec.	297 sec.

20 minutes nominal trip length
(actual trip length = 1167 (19.45 min.) for gas
and 1199 sec (19.9 min.) for diesel.)

This cycle has the following city and N-F/F weighting.

*This problem is more fully discussed in the Addendum to the EPA Technical Report "Selection of Transient Cycles for Heavy-Duty Engines," (HDV 77-01) by T. Wysor and C. France, November 1977.

Table 6

City and Non-Freeway/Freeway Weighting

Category	City Weighting Desired	City Weighting Actual	Non-Freeway Weighting Desired	Non-Freeway Weighting Actual	Freeway Weighting Desired	Freeway Weighting Actual
LA Gas	.50	.47	.30	.26	.20	.27
NY Gas	.50	.53	.44	.47	.06	0
LA Diesel	.50	.50	.24	.25	.26	.25
NY Diesel	.50	.50	.41	.50	.09	0

The opening segment for the cycle above was justified earlier. The second New York segment was not chosen for the second segment because emissions under New York driving conditions would be measured while the engine was either cold or partilly warm (at least for the cold start test). No stabilized emission results from New York type operation would be available. Instead, the LA N-F cycle was selected for the second segment. This cycle was chosen so as not to demand high power and speed from the engine (as would be required by the LA F cycle) before it was fully warmed-up. The LA F cycle was selected for the third segment and the NY N-F cycle concludes the composite cycle. This composite cycle would be run for both hot and cold start tests.

Finally, Table 7 compares the average between % RPM, average % power, and the % idle for the composite cycle and the CAPE-21 data base. Table 7 clearly illustrates that the proposed cycle approximates the CAPE-21 % RPM, % power and % Idle quite closely.

Table 7

Engine Cycle	Average % RPM Desired	Average % RPM Actual	Average % POWER Desired	Average % POWER Actual	% Idle Desired	% Idle Actual
Gasoline	29	30	33	36	26	27
Diesel	46	42	30	28	32	36

A complete listing of the gasoline and diesel engine cycles can be found in Appendix II.

2) Finalized Chassis Cycles

The finalized chassis cycle was arranged in the same manner as the engine cycles and the same logic was used. The resulting composite cycle for chassis testing is shown below.

Figure 4

Finalized Chassis Cycle
(Gasoline and Diesel)

Segment No:	1	2	3	4
	NY N-F	LA N-F	LA F	NY N-F
	254 sec.	285 sec.	267 sec.	254 sec.

20 minute nominal trip length
(actual trip length = 1060 sec., 17.67 min.)

The summary statistics for this chassis cycle are shown in Table 8. The chassis cycle segment weighting parallels the engine cycles' weighting very closely. Also, the chassis cycle's summary statistics are comparable to those of CAPE-21. A listing of the finalized chassis cycle is located in Appendix III.

3) Exhaust Emission Calculation Equations

a) Engine Cycles

For engine emission testing, emission levels are usually presented in terms of grams of pollutant per brake horsepower-hour. This method of expressing emission levels removes inequities between small and large engines, and places both on the same comparative scale. With respect to HD transient emission testing, it would be desirous to obtain total grams of pollutant per brake horsepower-hour for an average trip weighted appropriately for hot and cold trips. The following equation enables calculation of emission levels, in grams per brake horsepower-hour, for the engine emission cycle shown in Figure 3.

Equation (1)
$$A_{wm} = \frac{1/7(g_c) + 6/7(g_h)}{1/7(BHP\text{-}Hr_c) + 6/7(BHP\text{-}Hr_h)}$$

Where:

A_{wm} = Weighted mass emission level (HC, CO, CO_2, or NOx) in grams per brake horsepower-hour.

g_c = Mass emission level in grams, measured during the cold start test.

g_h = Mass emission level in grams, measured during the hot start test.

Table 8

Chassis Cycle Summary Statistics

Category	City Weighting Desired	City Weighting Actual	Non-Freeway Weighting Desired	Non-Freeway Weighting Actual	Freeway Weighting Desired	Freeway Weighting Actual	Miles per Trip[3] Desired	Miles per Trip[3] Actual	Average Speed (mph) per Trip Desired	Average Speed (mph) per Trip Actual
LA Gas and Diesel	.50	.52	.28	.27	.22	.25	4.59	5.55	15.99[1]	18.86
							(5.73)		(19.45)[2]	
NY Gas and Diesel	.50	.48	.43	.48	.07	0				

[1] This value was derived from the means of the trip values. Each trip is weighted equally regardless of trip length.

[2] The average speed for each truck category was used to calculate this value. The calculation technique is shown below.

Average speed per trip = (Avg. speed, LA Non-Freeway) .28 + (Avg. speed, LA Freeway) .22 + (Avg. speed, NY Non-Freeway) .43 + (Avg. speed, NY Freeway) .07

and

	Average Speed (MPH) Non-Freeway	Freeway
LA Gas & Diesel	15.10	45.54
NY Gas & Diesel	7.80	26.39

therefore

Avg. speed per trip = (15.10) .28 + (45.54) .22 + (7.80) .43 + (26.39) .07 = 19.45 MPH

[3] Miles per trip = (Average speed per trip)(Trip cycle duration)

$$= (\text{Average speed per trip})\left(\frac{17.67}{60}\right)$$

$BHP\text{-}Hr_c$ = Total brake horsepower-hour (brake horsepower integrated with respect to time) for the cold start test.

$BHP\text{-}Hr_h$ = Total brake horsepower-hour (brake horsepower integrated with respect to time) for the hot start test.

The numerator in Equation (1) would equal the total grams of pollutant measured during an average trip (as derived from the CAPE-21 data base). This gram value is weighted appropriately for the typical number of cold and hot trips occuring in a truck's daily operation. Similarly, the denominator represents the total hot/cold weighted, brake horsepower-hour (work) output during the trip.

b) Chassis Cycle

Emission levels for chassis emission testing are presented in terms of grams of pollutant per mile traveled. The following equation produces hot/cold weighted mass emissions per vehicle mile for the HD chassis cycle in Figure 4.

Equation (2)
$$A_{wm} = \frac{1/7(g_c) + 6/7(g_h)}{5.55}$$

Where:

A_{wm} = Weighted mass emission level (HC, CO, CO_2, or NOx) in grams per vehicle mile.

g_c = Mass emission level in grams, measured during the cold start test.

g_h = Mass emission level in grams, measured during the hot start test.

The numerator produces the hot/cold weighted mass of pollutant measured during the cycle (same as for engine cycles). The numerical value which is in the denominator equals the total number of miles traveled during the cycle.

D. Conclusions

Figures 3 and 4 present cycle segment arrangements for transient engine and transient chassis emission testing respectively. (Listings of all cycles are located in Appendix II and II.) A

complete emission test would consist of a cold start and a hot start cycle run. Equation (1) provides the means of calculating emission levels for engine testing. The calculated emission levels will be in grams per brake horsepower-hour. Similarly, for chassis testing Equation (2) is used to calculate weighted grams of pollutant per vehicle mile.

The cycle arrangements derived in this report are fundamentally based on the CAPE-21 data base and the cycles generated from it. In some instances more than one choice or approach was available. In these cases practical consideration and engineering judgment were used to aid in the selection of the finalized cycle. The finalized composite cycle exhibits trip characteristics supported by the CAPE-21 data base and can be considered a typical urban trip for a HD truck.

APPENDIX I

Reordered New York Non-Freeway Segments

(Engine and Chassis)

Reordered New York Non-Freeway Gasoline Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
0.	0.0	0.0	50.	0.0	0.0	100.	63.66	23.42	150.	0.0	2.16
1.	0.0	0.0	51.	0.0	10.11	101.	64.14	17.84	151.	0.0	0.0
2.	0.0	0.0	52.	4.32	46.40	102.	59.56	3.76	152.	0.0	0.0
3.	0.0	0.0	53.	8.91	45.17	103.	38.00	42.26	153.	0.0	0.0
4.	0.0	0.0	54.	1.95	50.00	104.	39.09	30.00	154.	0.83	MOTORING
5.	0.0	0.0	55.	3.33	41.68	105.	40.00	30.00	155.	2.00	MOTORING
6.	0.0	0.0	56.	4.00	89.46	106.	34.85	47.18	156.	0.54	MOTORING
7.	0.0	0.0	57.	13.76	55.60	107.	32.03	10.33	157.	0.0	MOTORING
8.	0.0	0.0	58.	26.43	26.96	108.	34.00	33.48	158.	0.0	MOTORING
9.	0.0	0.0	59.	33.85	6.16	109.	34.00	50.00	159.	0.0	MOTORING
10.	0.0	0.0	60.	36.00	MOTORING	110.	33.02	20.69	160.	0.0	MOTORING
11.	0.0	0.0	61.	34.45	MOTORING	111.	25.54	MOTORING	161.	0.0	0.0
12.	0.0	0.0	62.	34.00	MOTORING	112.	15.57	MOTORING	162.	0.0	0.0
13.	0.0	0.0	63.	35.64	MOTORING	113.	14.00	MOTORING	163.	0.0	0.0
14.	0.0	0.0	64.	32.99	27.39	114.	14.47	27.64	164.	0.0	0.0
15.	0.0	0.0	65.	36.00	80.00	115.	18.00	4.49	165.	0.0	0.0
16.	0.0	0.0	66.	41.63	74.37	116.	17.13	MOTORING	166.	0.0	MOTORING
17.	0.0	0.0	67.	40.41	26.76	117.	16.00	MOTORING	167.	0.0	22.01
18.	0.0	0.0	68.	48.44	MOTORING	118.	10.02	MOTORING	168.	1.23	72.29
19.	0.0	0.0	69.	43.86	MOTORING	119.	9.81	MOTORING	169.	6.63	80.00
20.	0.0	0.0	70.	40.39	MOTORING	120.	5.88	MOTORING	170.	17.29	89.29
21.	0.0	0.0	71.	38.50	4.01	121.	4.00	MOTORING	171.	22.17	90.00
22.	0.0	0.0	72.	35.05	30.00	122.	4.00	MOTORING	172.	24.00	82.79
23.	0.0	0.0	73.	40.64	16.70	123.	2.93	MOTORING	173.	24.00	31.96
24.	0.0	0.0	74.	43.64	26.45	124.	0.62	MOTORING	174.	24.00	MOTORING
25.	-1.78	44.40	75.	45.96	MOTORING	125.	0.0	MOTORING	175.	22.57	MOTORING
26.	0.0	85.35	76.	47.10	MOTORING	126.	0.0	MOTORING	176.	22.00	MOTORING
27.	4.25	100.00	77.	49.29	MOTORING	127.	0.0	MOTORING	177.	13.88	MOTORING
28.	27.47	100.00	78.	37.10	MOTORING	128.	0.0	MOTORING	178.	10.00	MOTORING
29.	42.96	100.00	79.	36.00	MOTORING	129.	0.0	MOTORING	179.	9.31	MOTORING
30.	45.79	100.00	80.	34.47	MOTORING	130.	0.0	10.00	180.	3.99	MOTORING
31.	48.11	99.46	81.	32.15	MOTORING	131.	0.0	10.00	181.	0.0	0.0
32.	50.42	90.00	82.	31.67	MOTORING	132.	0.0	29.02	182.	0.0	0.0
33.	52.74	75.23	83.	28.48	13.89	133.	0.0	27.83	183.	0.0	0.0
34.	54.00	50.00	84.	32.38	90.00	134.	0.0	7.34	184.	0.0	0.0
35.	44.47	8.96	85.	36.00	90.00	135.	0.0	0.0	185.	0.0	0.0
36.	45.33	MOTORING	86.	41.69	90.00	136.	0.0	0.0	186.	0.0	0.0
37.	46.08	9.99	87.	45.74	90.00	137.	0.0	0.0	187.	0.0	0.0
38.	37.69	MOTORING	88.	49.95	80.00	138.	0.0	0.0	188.	0.0	0.0
39.	31.61	5.68	89.	49.10	80.00	139.	0.0	0.0	189.	0.0	0.0
40.	22.94	35.29	90.	50.59	62.97	140.	0.0	0.0	190.	0.0	0.0
41.	24.00	4.87	91.	45.99	34.98	141.	0.0	0.0	191.	0.0	0.0
42.	20.86	MOTORING	92.	42.76	7.23	142.	0.0	0.0	192.	0.0	0.0
43.	12.45	MOTORING	93.	35.12	MOTORING	143.	0.0	0.0	193.	0.0	0.0
44.	6.00	MOTORING	94.	32.06	67.92	144.	0.0	0.0	194.	0.0	0.0
45.	6.52	MOTORING	95.	35.53	82.55	145.	0.0	0.0	195.	0.0	0.0
46.	7.17	MOTORING	96.	46.57	68.60	146.	2.00	0.0	196.	0.0	0.0
47.	2.55	MOTORING	97.	49.77	48.85	147.	1.38	0.0	197.	0.0	0.0
48.	0.0	0.0	98.	52.00	60.00	148.	0.0	0.0	198.	0.0	0.0
49.	0.0	0.0	99.	58.06	60.00	149.	0.0	6.27	199.	0.0	0.0

Reordered New York Non-Freeway Gasoline Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
200.	0.0	0.0	250.	0.0	0.0
201.	0.0	0.0	251.	0.0	0.0
202.	0.0	0.0	252.	0.0	0.0
203.	0.0	0.0	253.	0.0	0.0
204.	-2.52	6.30	254.	0.0	0.0
205.	-4.22	15.28	255.	0.0	0.0
206.	0.0	10.00	256.	0.0	0.0
207.	0.0	10.00	257.	0.0	0.0
208.	0.0	10.00	258.	0.0	0.0
209.	0.0	75.93	259.	0.0	0.0
210.	0.0	32.22	260.	0.0	0.0
211.	1.67	35.00	261.	0.0	0.0
212.	15.48	29.82	262.	0.0	0.0
213.	25.46	MOTORING	263.	0.0	0.0
214.	24.22	MOTORING	264.	0.0	0.0
215.	23.44	MOTORING	265.	0.0	0.0
216.	12.41	80.00	266.	0.0	0.0
217.	8.94	83.61	267.	0.0	0.0
218.	7.25	84.82	268.	0.0	0.0
219.	16.70	80.00	269.	0.0	0.0
220.	24.67	63.33	270.	0.0	0.0
221.	0.24	79.81	271.	0.0	0.0
222.	0.0	8.52	272.	0.0	0.0
223.	0.0	0.0			
224.	0.0	0.0			
225.	0.0	0.0			
226.	0.0	0.0			
227.	0.0	0.0			
228.	0.0	0.0			
229.	0.0	0.0			
230.	0.0	0.0			
231.	0.0	0.0			
232.	0.0	0.0			
233.	0.0	17.59			
234.	0.0	19.63			
235.	0.0	10.00			
236.	0.0	10.00			
237.	0.0	10.00			
238.	0.0	3.34			
239.	0.0	0.0			
240.	0.0	0.0			
241.	0.0	0.0			
242.	0.0	0.0			
243.	0.0	0.0			
244.	0.0	0.0			
245.	0.0	0.0			
246.	0.0	0.0			
247.	0.0	0.0			
248.	0.0	0.0			
249.	0.0	0.0			

Reordered New York Non-Freeway Diesel Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
0.	0.0	0.0	50.	54.03	79.92	100.	0.0	0.0	150.	0.0	0.0
1.	0.0	0.0	51.	58.00	65.03	101.	0.0	0.0	151.	0.0	0.0
2.	0.0	0.0	52.	58.65	43.23	102.	0.0	0.0	152.	0.0	0.0
3.	0.0	0.0	53.	62.88	50.00	103.	0.0	0.0	153.	0.0	0.0
4.	0.0	0.0	54.	69.83	50.00	104.	0.0	0.0	154.	0.0	0.0
5.	0.0	0.0	55.	72.00	42.05	105.	0.0	0.0	155.	0.0	0.0
6.	0.0	0.0	56.	75.81	40.00	106.	0.0	0.0	156.	0.0	0.0
7.	0.0	0.0	57.	84.22	42.20	107.	0.0	0.0	157.	0.0	0.0
8.	0.0	0.0	58.	83.86	41.28	108.	0.0	0.0	158.	0.0	0.21
9.	0.0	0.0	59.	80.55	MOTORING	109.	0.0	0.0	159.	0.0	30.00
10.	0.0	0.0	60.	80.51	MOTORING	110.	0.0	0.0	160.	0.0	26.78
11.	0.0	0.0	61.	78.00	MOTORING	111.	0.0	0.0	161.	0.0	20.00
12.	0.0	0.0	62.	79.79	MOTORING	112.	0.0	0.0	162.	0.0	20.00
13.	0.0	0.0	63.	80.33	30.54	113.	0.0	0.0	163.	0.0	4.12
14.	0.0	0.0	64.	85.59	42.12	114.	0.0	0.0	164.	0.0	0.0
15.	0.0	0.0	65.	81.78	50.00	115.	0.0	0.0	165.	0.0	0.0
16.	0.0	0.0	66.	78.00	50.00	116.	0.0	0.0	166.	0.0	0.0
17.	0.0	0.0	67.	80.74	43.16	117.	0.0	0.0	167.	0.0	0.0
18.	0.0	0.0	68.	92.10	73.65	118.	0.0	0.0	168.	0.0	0.0
19.	0.0	0.0	69.	88.01	MOTORING	119.	0.0	0.0	169.	0.0	0.0
20.	0.0	0.0	70.	84.00	MOTORING	120.	0.0	0.0	170.	0.0	0.0
21.	0.0	0.0	71.	84.00	MOTORING	121.	0.0	0.0	171.	0.0	0.0
22.	0.0	0.0	72.	81.17	MOTORING	122.	0.0	0.0	172.	0.0	0.0
23.	0.0	0.0	73.	70.46	MOTORING	123.	0.0	0.0	173.	0.0	0.0
24.	0.0	0.0	74.	66.00	13.57	124.	0.0	0.0	174.	0.0	0.0
25.	0.0	3.67	75.	62.23	29.43	125.	0.0	0.0	175.	0.0	0.0
26.	0.0	47.69	76.	64.00	20.00	126.	0.0	0.0	176.	0.0	0.0
27.	3.11	59.41	77.	63.48	17.42	127.	0.0	0.0	177.	0.0	0.0
28.	9.09	64.54	78.	60.34	10.00	128.	0.0	0.0	178.	0.0	0.0
29.	15.62	80.00	79.	56.85	10.00	129.	1.77	MOTORING	179.	0.0	0.0
30.	33.49	80.00	80.	56.00	MOTORING	130.	1.60	MOTORING	180.	0.0	0.0
31.	37.93	79.29	81.	52.45	MOTORING	131.	0.0	MOTORING	181.	0.0	0.0
32.	31.20	38.25	82.	39.91	10.00	132.	0.0	0.0	182.	0.0	0.0
33.	21.99	26.67	83.	36.38	10.00	133.	2.14	9.28	183.	0.0	0.0
34.	30.00	15.10	84.	30.00	10.00	134.	3.08	0.0	184.	0.0	20.00
35.	22.23	16.47	85.	27.93	10.00	135.	0.0	0.0	185.	0.0	20.00
36.	19.61	28.05	86.	26.00	16.74	136.	0.0	0.0	186.	0.0	11.73
37.	20.00	20.38	87.	27.66	3.36	137.	0.0	0.0	187.	0.0	0.0
38.	18.33	MOTORING	88.	28.00	MOTORING	138.	0.0	0.0	188.	0.0	0.0
39.	6.55	MOTORING	89.	27.41	MOTORING	139.	0.0	0.0	189.	0.0	0.0
40.	15.82	MOTORING	90.	20.96	MOTORING	140.	0.0	0.0	190.	0.0	0.0
41.	23.63	MOTORING	91.	12.15	MOTORING	141.	0.0	0.0	191.	0.0	0.0
42.	17.51	MOTORING	92.	3.81	MOTORING	142.	0.0	0.0	192.	0.0	0.0
43.	14.14	62.52	93.	0.0	MOTORING	143.	0.0	0.0	193.	0.0	0.0
44.	16.64	69.36	94.	0.0	MOTORING	144.	0.0	0.0	194.	0.0	0.0
45.	27.77	60.00	95.	0.0	0.91	145.	0.0	0.0	195.	0.0	0.0
46.	37.03	63.79	96.	0.0	7.52	146.	0.0	0.0	196.	0.0	0.0
47.	47.35	75.36	97.	0.0	0.0	147.	0.0	5.51	197.	0.0	0.0
48.	54.77	80.00	98.	0.0	0.0	148.	0.0	11.34	198.	0.0	0.0
49.	57.70	80.00	99.	0.0	0.0	149.	0.0	0.0	199.	0.0	0.0

Reordered New York Non-Freeway Diesel Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
200.	0.0	0.0	250.	23.05	60.97
201.	0.0	0.0	251.	18.20	27.34
202.	0.0	0.0	252.	12.84	43.71
203.	0.0	0.0	253.	10.10	58.95
204.	0.0	0.0	254.	3.79	58.95
205.	0.0	0.0	255.	1.48	44.28
206.	0.0	0.0	256.	0.0	0.0
207.	0.0	0.0	257.	0.0	0.0
208.	0.0	0.0	258.	0.0	0.0
209.	0.0	0.0	259.	0.0	0.0
210.	0.0	0.0	260.	0.0	0.0
211.	0.0	0.0	261.	0.0	0.0
212.	0.0	0.0	262.	0.0	0.0
213.	0.0	0.0	263.	0.0	24.97
214.	0.0	73.41	264.	0.0	17.16
215.	0.0	90.00	265.	0.0	6.20
216.	31.30	81.30	266.	0.0	10.00
217.	41.15	90.00	267.	0.0	10.00
218.	44.00	90.00	268.	0.0	0.0
219.	46.41	90.00	269.	0.0	0.0
220.	51.04	82.41	270.	0.0	0.0
221.	66.66	80.00	271.	0.0	0.0
222.	75.03	90.00	272.	0.0	0.0
223.	89.85	90.00	273.	0.0	0.0
224.	96.74	93.83	274.	0.0	0.0
225.	96.91	50.94	275.	0.0	0.0
226.	94.60	17.02	276.	0.0	0.0
227.	99.16	28.60	277.	0.0	0.0
228.	100.00	39.83	278.	0.0	0.0
229.	100.00	30.00	279.	0.0	0.0
230.	100.00	26.69	280.	0.0	0.0
231.	100.98	20.00	281.	0.0	0.0
232.	100.71	20.00	282.	0.0	0.0
233.	100.00	36.06	283.	0.0	0.0
234.	96.16	40.00	284.	0.0	0.0
235.	95.77	30.00	285.	0.0	0.0
236.	94.55	32.75	286.	0.0	0.0
237.	96.86	35.68	287.	0.0	0.0
238.	99.18	30.00	288.	0.0	0.0
239.	100.00	44.93	289.	0.0	0.0
240.	101.81	50.00	290.	0.0	0.0
241.	86.54	MOTORING	291.	0.0	0.0
242.	63.56	MOTORING	292.	0.0	0.0
243.	56.00	MOTORING	293.	0.0	0.0
244.	46.00	MOTORING	294.	0.0	0.0
245.	41.86	45.18	295.	0.0	0.0
246.	38.31	78.47	296.	0.0	0.0
247.	35.98	80.00	297.	0.0	0.0
248.	31.03	80.00			
249.	25.35	80.00			

Reordered New York Non-Freeway Chassis Cycle (Gasoline and Diesel)

RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)
0.	0.0	50.	12.26	100.	31.01	150.	0.0	200.	0.0	250.	0.0
1.	0.0	51.	14.29	101.	31.00	151.	0.0	201.	0.0	251.	0.0
2.	0.0	52.	14.56	102.	31.62	152.	0.0	202.	0.0	252.	0.0
3.	0.0	53.	15.20	103.	33.00	153.	0.0	203.	4.15	253.	0.0
4.	0.0	54.	16.76	104.	32.37	154.	0.0	204.	6.00	254.	0.0
5.	0.0	55.	17.00	105.	30.43	155.	0.0	205.	6.00		
6.	0.0	56.	17.00	106.	30.00	156.	0.0	206.	6.00		
7.	0.0	57.	17.23	107.	30.00	157.	0.0	207.	5.30		
8.	0.0	58.	18.77	108.	30.51	158.	0.0	208.	4.14		
9.	0.0	59.	20.54	109.	32.41	159.	0.0	209.	1.96		
10.	0.0	60.	19.60	110.	33.00	160.	0.0	210.	0.0		
11.	0.0	61.	18.14	111.	32.27	161.	0.0	211.	0.0		
12.	0.0	62.	17.98	112.	32.00	162.	0.0	212.	0.0		
13.	0.0	63.	17.00	113.	31.04	163.	0.0	213.	0.0		
14.	0.0	64.	16.34	114.	32.20	164.	0.0	214.	0.0		
15.	0.0	65.	15.00	115.	33.36	165.	0.0	215.	0.0		
16.	0.0	66.	15.00	116.	34.00	166.	0.0	216.	0.0		
17.	0.0	67.	15.00	117.	34.00	167.	0.0	217.	0.0		
18.	0.0	68.	15.96	118.	34.00	168.	0.0	218.	0.0		
19.	0.0	69.	12.35	119.	33.01	169.	0.0	219.	0.0		
20.	0.0	70.	15.28	120.	31.86	170.	0.0	220.	0.0		
21.	0.0	71.	14.27	121.	30.10	171.	0.0	221.	0.0		
22.	0.0	72.	12.59	122.	26.17	172.	0.0	222.	0.0		
23.	0.0	73.	12.25	123.	23.39	173.	0.0	223.	0.0		
24.	0.0	74.	9.28	124.	21.46	174.	0.51	224.	0.0		
25.	0.19	75.	8.00	125.	17.28	175.	0.33	225.	0.0		
26.	1.00	76.	8.00	126.	15.83	176.	0.0	226.	0.0		
27.	1.51	77.	8.38	127.	13.76	177.	0.0	227.	0.0		
28.	2.66	78.	9.53	128.	12.60	178.	0.0	228.	0.0		
29.	4.64	79.	10.69	129.	10.33	179.	0.0	229.	0.0		
30.	6.96	80.	11.00	130.	8.28	180.	0.0	230.	0.0		
31.	8.86	81.	9.00	131.	5.38	181.	0.0	231.	0.48		
32.	7.71	82.	9.00	132.	2.91	182.	0.0	232.	1.64		
33.	7.45	83.	9.32	133.	0.0	183.	0.0	233.	0.41		
34.	9.22	84.	10.00	134.	0.0	184.	0.0	234.	0.0		
35.	10.00	85.	9.36	135.	0.0	185.	0.0	235.	0.0		
36.	9.08	86.	9.00	136.	0.0	186.	0.0	236.	0.0		
37.	10.08	87.	9.95	137.	0.0	187.	0.0	237.	0.0		
38.	11.24	88.	14.33	138.	0.0	188.	0.0	238.	0.0		
39.	12.79	89.	17.53	139.	0.0	189.	0.0	239.	0.0		
40.	14.00	90.	19.42	140.	0.0	190.	0.0	240.	0.0		
41.	12.58	91.	20.00	141.	0.0	191.	0.0	241.	0.0		
42.	12.87	92.	20.74	142.	0.0	192.	0.0	242.	0.0		
43.	13.00	93.	21.00	143.	0.0	193.	0.0	243.	0.0		
44.	13.00	94.	21.11	144.	0.0	194.	0.0	244.	0.0		
45.	13.68	95.	23.84	145.	0.0	195.	0.0	245.	0.0		
46.	15.00	96.	27.00	146.	0.0	196.	0.0	246.	0.0		
47.	15.00	97.	27.00	147.	0.0	197.	0.13	247.	0.0		
48.	13.37	98.	29.05	148.	0.0	198.	0.71	248.	0.0		
49.	12.03	99.	32.52	149.	0.0	199.	0.0	249.	0.0		

APPENDIX II

Finalized Transient Engine Cycles

(Gasoline and Diesel)

Gasoline Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
0.	0.0	0.0	50.	0.0	0.0	100.	63.65	23.42	150.	0.0	2.16
1.	0.0	0.0	51.	0.0	10.11	101.	64.14	17.84	151.	0.0	0.0
2.	0.0	0.0	52.	4.33	40.40	102.	59.58	3.76	152.	0.0	0.0
3.	0.0	0.0	53.	8.90	45.17	103.	58.00	42.26	153.	0.0	0.0
4.	0.0	0.0	54.	1.95	50.00	104.	59.09	30.00	154.	0.83	MOTORING
5.	0.0	0.0	55.	3.33	41.58	105.	60.00	30.00	155.	2.00	MOTORING
6.	0.0	0.0	56.	4.00	39.46	106.	34.85	47.18	156.	0.54	MOTORING
7.	0.0	0.0	57.	13.75	35.60	107.	32.03	10.33	157.	0.0	MOTORING
8.	0.0	0.0	58.	25.43	25.96	108.	34.00	33.48	158.	0.0	MOTORING
9.	0.0	0.0	59.	33.35	5.16	109.	34.00	50.00	159.	0.0	MOTORING
10.	0.0	0.0	60.	36.00	MOTORING	110.	33.07	20.69	160.	0.0	MOTORING
11.	0.0	0.0	61.	34.45	MOTORING	111.	25.54	MOTORING	161.	0.0	0.0
12.	0.0	0.0	62.	34.00	MOTORING	112.	15.57	MOTORING	162.	0.0	0.0
13.	0.0	0.0	63.	35.64	MOTORING	113.	14.00	MOTORING	163.	0.0	0.0
14.	0.0	0.0	64.	32.35	27.39	114.	14.47	27.64	164.	0.0	0.0
15.	0.0	0.0	65.	36.00	50.00	115.	18.60	4.49	165.	0.0	0.0
16.	0.0	0.0	66.	41.63	24.37	116.	17.13	MOTORING	166.	0.0	MOTORING
17.	0.0	0.0	67.	50.41	26.76	117.	16.09	MOTORING	167.	0.0	22.01
18.	0.0	0.0	68.	48.44	MOTORING	118.	10.02	MOTORING	168.	1.23	72.29
19.	0.0	0.0	69.	43.86	MOTORING	119.	9.81	MOTORING	169.	5.63	50.00
20.	0.0	0.0	70.	40.33	MOTORING	120.	5.86	MOTORING	170.	17.29	49.29
21.	0.0	0.0	71.	38.56	4.01	121.	4.00	MOTORING	171.	22.17	50.00
22.	0.0	0.0	72.	35.05	50.00	122.	4.00	MOTORING	172.	24.00	82.70
23.	0.0	0.0	73.	40.56	16.70	123.	2.93	MOTORING	173.	24.00	31.95
24.	0.0	0.0	74.	43.54	25.45	124.	0.62	MOTORING	174.	24.00	MOTORING
25.	-1.78	44.40	75.	45.96	MOTORING	125.	0.0	MOTORING	175.	22.57	MOTORING
26.	0.0	85.35	76.	47.15	MOTORING	126.	0.0	MOTORING	176.	22.00	MOTORING
27.	4.23	100.00	77.	49.23	MOTORING	127.	0.0	MOTORING	177.	13.85	MOTORING
28.	27.47	100.00	78.	37.10	MOTORING	128.	0.0	MOTORING	178.	10.00	MOTORING
29.	42.45	100.00	79.	35.03	MOTORING	129.	0.0	MOTORING	179.	5.31	MOTORING
30.	45.74	100.00	80.	34.47	MOTORING	130.	0.0	10.00	180.	3.99	MOTORING
31.	43.11	99.45	81.	32.15	MOTORING	131.	0.0	10.00	181.	0.0	0.0
32.	50.42	90.00	82.	31.67	MOTORING	132.	0.0	29.02	182.	0.0	0.0
33.	53.74	75.23	83.	28.48	13.59	133.	0.0	27.83	183.	0.0	0.0
34.	54.01	50.00	84.	32.39	40.00	134.	0.0	7.34	184.	0.0	0.0
35.	44.42	8.35	85.	35.00	40.00	135.	0.0	0.0	185.	0.0	0.0
36.	45.05	MOTORING	86.	41.60	40.00	136.	0.0	0.0	186.	0.0	0.0
37.	46.0	9.04	87.	45.74	40.00	137.	0.0	0.0	187.	0.0	0.0
38.	37.23	MOTORING	88.	49.96	40.00	138.	0.0	0.0	188.	0.0	0.0
39.	31.51	5.08	89.	49.10	50.00	139.	0.0	0.0	189.	0.0	0.0
40.	22.74	35.29	90.	50.53	52.97	140.	0.0	0.0	190.	0.0	0.0
41.	24.00	4.87	91.	45.96	34.98	141.	0.0	0.0	191.	0.0	0.0
42.	20.55	MOTORING	92.	42.75	7.23	142.	0.0	0.0	192.	0.0	0.0
43.	12.45	MOTORING	93.	35.12	MOTORING	143.	0.0	0.0	193.	0.0	0.0
44.	6.0	MOTORING	94.	32.06	57.42	144.	0.0	0.0	194.	0.0	0.0
45.	5.5	MOTORING	95.	35.53	52.35	145.	0.0	0.0	195.	0.0	0.0
46.	7.17	MOTORING	96.	46.37	50.00	146.	2.00	0.0	196.	0.0	0.0
47.	2.55	MOTORING	97.	49.77	48.85	147.	1.35	0.0	197.	0.0	0.0
48.	0.0	0.0	98.	52.03	50.00	148.	0.0	0.0	198.	0.0	0.0
49.	0.0	0.0	99.	54.36	50.00	149.	0.0	6.27	199.	0.0	0.0

Gasoline Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
200.	0.0	0.0	250.	0.0	0.0	300.	0.0	4.07	350.	48.22	50.00
201.	0.0	0.0	251.	0.0	0.0	301.	0.0	10.00	351.	54.21	58.69
202.	0.0	0.0	252.	0.0	0.0	302.	0.0	17.22	352.	67.14	70.00
203.	0.0	0.0	253.	0.0	0.0	303.	0.0	20.00	353.	71.00	70.00
204.	-2.32	6.30	254.	0.0	0.0	304.	0.0	20.37	354.	72.00	70.00
205.	-4.67	15.28	255.	0.0	0.0	305.	2.33	31.94	355.	72.13	68.08
206.	0.0	10.00	256.	0.0	0.0	306.	16.22	36.48	356.	74.84	28.94
207.	0.0	10.00	257.	0.0	0.0	307.	24.00	24.91	357.	58.91	MOTORING
208.	0.0	10.00	258.	0.0	0.0	308.	24.00	13.34	358.	44.71	MOTORING
209.	0.0	75.93	259.	0.0	0.0	309.	19.06	10.00	359.	41.84	MOTORING
210.	0.0	32.22	260.	0.0	0.0	310.	18.00	MOTORING	360.	38.30	MOTORING
211.	1.67	35.00	261.	0.0	0.0	311.	17.17	MOTORING	361.	35.93	MOTORING
212.	15.45	29.82	262.	0.0	0.0	312.	9.04	MOTORING	362.	28.00	MOTORING
213.	25.45	MOTORING	263.	0.0	0.0	313.	1.05	MOTORING	363.	23.42	MOTORING
214.	24.22	MOTORING	264.	0.0	0.0	314.	0.0	0.0	364.	10.15	MOTORING
215.	23.34	MOTORING	265.	0.0	0.0	315.	0.0	0.0	365.	4.72	MOTORING
216.	12.41	80.00	266.	0.0	0.0	316.	0.0	0.0	366.	0.82	5.90
217.	5.44	83.51	267.	0.0	0.0	317.	0.0	0.0	367.	-9.53	19.53
218.	7.25	84.42	268.	0.0	0.0	318.	0.0	0.0	368.	2.20	45.60
219.	16.7	80.00	269.	0.0	0.0	319.	0.0	0.0	369.	20.53	7.33
220.	24.67	63.33	270.	0.0	0.0	320.	0.0	0.0	370.	21.1-	0.0
221.	0.2-	79.41	271.	0.0	0.0	321.	0.0	0.0	371.	17.67	MOTORING
222.	0.0	8.52	272.	0.0	0.0	322.	0.0	0.0	372.	13.0-	MOTORING
223.	0.0	0.0	273.	0.0	0.0	323.	0.0	0.82	373.	8.41	79.70
224.	0.0	0.0	274.	0.0	0.0	324.	0.37	41.08	374.	10.33	100.00
225.	0.0	0.0	275.	0.0	0.0	325.	2.66	90.00	375.	17.27	100.00
226.	0.0	0.0	276.	0.0	0.0	326.	6.00	94.99	376.	22.00	100.00
227.	0.0	0.0	277.	0.0	0.0	327.	11.34	100.00	377.	25.14	100.00
228.	0.0	0.0	278.	0.0	0.0	328.	15.63	100.00	378.	24.37	100.00
229.	0.0	0.0	279.	0.0	0.0	329.	41.26	90.28	379.	36.73	66.35
230.	0.0	0.0	280.	0.0	0.0	330.	46.26	90.00	380.	40.00	MOTORING
231.	0.0	0.0	281.	0.0	4.17	331.	44.56	67.08	381.	23.50	MOTORING
232.	0.0	0.0	282.	1.15	10.00	332.	36.00	1.12	382.	9.37	MOTORING
233.	0.0	17.59	283.	2.00	10.00	333.	27.55	50.12	383.	5.00	MOTORING
234.	0.0	19.63	284.	0.22	10.00	334.	23.36	90.00	384.	5.74	MOTORING
235.	0.0	10.00	285.	0.0	0.0	335.	24.00	90.00	385.	2.86	MOTORING
236.	0.0	10.00	286.	0.0	0.0	336.	26.24	70.00	386.	0.11	MOTORING
237.	0.0	10.00	287.	0.0	0.0	337.	30.00	65.38	387.	0.0	MOTORING
238.	0.0	3.34	288.	0.0	0.0	338.	30.60	34.47	388.	0.0	0.0
239.	0.0	0.0	289.	0.0	0.0	339.	30.00	10.00	389.	0.0	0.0
240.	0.0	0.0	290.	0.0	0.0	340.	30.00	10.00	390.	0.0	0.0
241.	0.0	0.0	291.	0.0	0.0	341.	30.00	10.00	391.	0.0	0.0
242.	0.0	0.0	292.	0.0	0.0	342.	30.15	60.00	392.	0.0	0.0
243.	0.0	0.0	293.	0.0	0.0	343.	40.00	58.25	393.	0.0	0.0
244.	0.0	0.0	294.	0.0	0.0	344.	40.67	50.00	394.	0.0	0.0
245.	0.0	0.0	295.	0.0	0.0	345.	41.32	50.00	395.	0.0	0.0
246.	0.0	0.0	296.	0.0	0.0	346.	40.00	50.00	396.	0.0	0.0
247.	0.0	0.0	297.	0.0	0.0	347.	41.61	50.00	397.	0.0	0.0
248.	0.0	0.0	298.	0.0	0.0	348.	42.00	50.00	398.	0.0	0.0
249.	0.0	0.0	299.	0.0	0.0	349.	45.00	50.00	399.	0.0	0.0

Gasoline Engine Cycle

RECOR (SEC)	XRW	XPOWER	RECORD (SEC)	XRPM	XPOWER	RECORD (SEC)	XRPM	XPOWER	RECORD (SEC)	XRPM	XPOWER
400.	0.0	0.0	450.	37.37	MOTORING	500.	23.77	91.15	550.	36.00	37.46
401.	0.0	0.0	451.	35.31	MOTORING	501.	28.08	90.00	551.	36.00	40.00
402.	0.0	0.0	452.	40.60	MOTORING	502.	30.00	86.01	552.	34.00	40.00
403.	0.0	0.0	453.	27.02	MOTORING	503.	32.85	80.70	553.	34.00	40.00
404.	0.0	0.0	454.	26.00	MOTORING	504.	32.58	100.00	554.	34.00	36.25
405.	0.0	0.0	455.	26.00	MOTORING	505.	33.37	100.00	555.	38.24	24.68
406.	0.0	0.0	456.	20.24	MOTORING	506.	36.00	100.00	556.	43.3	51.38
407.	0.0	0.0	457.	14.00	MOTORING	507.	51.77	100.00	557.	50.78	46.12
408.	0.0	0.0	458.	13.45	18.27	508.	60.57	95.72	558.	52.00	19.92
409.	0.0	0.0	459.	9.40	32.99	509.	64.00	70.00	559.	52.32	0.0
410.	0.0	0.0	460.	10.72	51.81	510.	64.91	70.00	560.	52.64	3.14
411.	0.0	0.0	461.	15.30	47.48	511.	75.83	70.00	561.	48.00	10.00
412.	0.0	0.0	462.	19.82	100.00	512.	82.00	70.00	562.	48.00	10.00
413.	0.0	0.0	463.	20.25	100.00	513.	85.72	51.42	563.	48.00	10.00
414.	0.0	0.0	464.	25.78	100.00	514.	86.17	49.14	564.	38.94	19.48
415.	0.0	0.0	465.	35.02	100.00	515.	88.49	35.13	565.	28.00	20.00
416.	0.0	0.0	466.	42.14	44.65	516.	90.00	15.99	566.	28.00	20.00
417.	0.0	0.0	467.	44.00	40.00	517.	91.12	26.74	567.	28.00	15.81
418.	0.0	0.0	468.	45.70	40.00	518.	92.00	32.85	568.	28.00	10.00
419.	2.27	20.00	469.	51.34	30.00	519.	93.74	30.00	569.	26.53	10.00
420.	2.84	14.11	470.	50.00	30.00	520.	89.24	MOTORING	570.	26.00	10.00
421.	0.0	0.0	471.	51.24	33.22	521.	66.00	41.87	571.	23.71	MOTORING
422.	0.0	0.0	472.	54.95	70.00	522.	67.38	56.88	572.	17.5	MOTORING
423.	0.0	0.0	473.	56.00	70.00	523.	60.02	54.96	573.	11.65	MOTORING
424.	0.0	0.0	474.	52.35	56.25	524.	93.45	66.34	574.	1.92	MOTORING
425.	0.0	0.0	475.	71.51	50.00	525.	97.53	63.69	575.	0.0	0.0
426.	0.0	0.0	476.	76.22	50.00	526.	94.11	60.00	576.	0.0	0.0
427.	0.0	0.0	477.	78.00	50.00	527.	85.65	MOTORING	577.	0.0	0.0
428.	0.0	0.0	478.	78.00	41.53	528.	70.00	MOTORING	578.	0.0	0.0
429.	0.0	0.0	479.	55.93	12.58	529.	69.11	MOTORING	579.	0.0	0.0
430.	0.0	0.0	480.	38.52	0.0	530.	66.81	MOTORING	580.	0.0	0.0
431.	0.67	0.78	481.	34.42	71.65	531.	64.48	MOTORING	581.	0.0	0.0
432.	15.5	31.93	482.	16.11	79.67	532.	53.00	44.98	582.	0.0	0.0
433.	45.3	29.78	483.	38.34	57.90	533.	52.73	49.27	583.	1.2	25.19
434.	43.00	10.00	484.	42.76	50.00	534.	62.00	40.00	584.	5.72	47.87
435.	40.52	10.00	485.	44.00	44.75	535.	62.00	43.88	585.	13.67	40.56
436.	35.16	10.00	486.	49.48	35.35	536.	64.18	44.55	586.	15.20	80.00
437.	25.18	13.70	487.	52.00	30.00	537.	53.35	4.88	587.	18.52	80.00
438.	28.25	47.45	488.	42.00	MOTORING	538.	46.20	15.79	588.	25.83	75.83
439.	30.0	30.00	489.	25.50	0.0	539.	46.0	19.83	589.	35.1	70.00
440.	30.00	30.00	490.	24.00	0.0	540.	45.65	10.00	590.	38.93	77.31
441.	30.00	30.00	491.	24.00	MOTORING	541.	45.44	10.00	591.	41.78	80.00
442.	34.52	30.00	492.	20.24	MOTORING	542.	48.00	10.00	592.	40.00	10.00
443.	36.11	30.00	493.	10.18	38.43	543.	44.71	3.54	593.	40.00	20.18
444.	38.43	30.00	494.	8.05	50.58	544.	48.82	MOTORING	594.	40.00	52.78
445.	43.44	30.00	495.	10.25	30.79	545.	51.42	66.82	595.	40.00	34.82
446.	50.0	30.00	496.	13.54	70.0	546.	47.52	MOTORING	596.	41.00	30.00
447.	50.0	24.55	497.	18.00	44.13	547.	35.31	9.23	597.	40.00	38.33
448.	50.0	20.00	498.	20.20	100.0	548.	17.73	55.68	598.	40.00	40.04
449.	50.0	MOTORING	499.	22.00	100.0	549.	29.44	38.22	599.	38.30	100.00

Gasoline Engine Cycle

RECORD (SEC)	RPM	BPOWER
600.	40.51	100.00
601.	42.01	100.00
602.	42.01	100.00
603.	42.01	100.00
604.	42.01	100.00
605.	42.00	100.00
606.	43.51	97.50
607.	43.17	85.93
608.	43.17	85.85
609.	44.01	90.00
610.	44.01	90.00
611.	44.00	80.00
612.	44.01	80.00
613.	44.17	80.00
614.	45.00	74.41
615.	45.01	63.34
616.	45.01	60.00
617.	45.01	60.00
618.	44.01	10.00
619.	44.01	10.00
620.	44.01	10.00
621.	42.01	10.00
622.	42.01	10.00
623.	43.51	19.26
624.	50.01	90.00
625.	50.01	90.00
626.	50.01	90.00
627.	50.01	90.00
628.	50.01	90.00
629.	48.67	90.00
630.	48.01	84.73
631.	48.34	80.00
632.	43.34	80.00
633.	44.01	80.00
634.	48.17	80.00
635.	48.01	80.01
636.	48.01	78.28
637.	48.01	78.00
638.	48.01	78.01
639.	43.00	76.44
640.	44.01	61.96
641.	44.34	50.00
642.	50.01	50.00
643.	50.01	40.00
644.	50.01	44.22
645.	51.71	80.00
646.	52.01	80.00
647.	54.34	80.00
648.	52.01	80.00
649.	52.01	80.01

RECORD (SEC)	RPM	BPOWER
650.	54.00	40.00
651.	54.00	40.00
652.	54.00	33.10
653.	55.23	73.53
654.	56.00	70.00
655.	56.00	70.00
656.	56.00	50.00
657.	56.00	37.23
658.	56.34	30.30
659.	56.00	38.17
660.	56.00	30.00
661.	56.00	30.00
662.	54.00	34.36
663.	54.00	27.79
664.	54.00	20.00
665.	54.00	20.00
666.	54.00	20.00
667.	54.00	11.49
668.	54.00	0.08
669.	54.34	13.31
670.	54.00	30.00
671.	54.45	30.00
672.	57.22	30.00
673.	56.41	30.00
674.	57.41	30.00
675.	58.22	30.60
676.	60.00	40.00
677.	60.00	40.00
678.	60.00	43.42
679.	60.00	46.30
680.	60.00	40.00
681.	60.00	40.00
682.	60.42	40.00
683.	62.74	40.00
684.	65.15	40.00
685.	66.30	53.16
686.	66.30	71.54
687.	66.00	70.00
688.	66.00	70.00
689.	66.00	73.14
690.	66.00	80.00
691.	66.00	80.28
692.	66.00	80.00
693.	66.15	80.30
694.	68.29	100.00
695.	70.00	100.00
696.	70.00	100.00
697.	74.34	100.00
698.	78.00	100.00

RECORD (SEC)	RPM	BPOWER
700.	72.09	100.00
701.	73.60	100.00
702.	72.00	100.00
703.	72.00	100.00
704.	72.00	100.00
705.	72.00	100.00
706.	72.00	100.00
707.	72.29	100.00
708.	73.34	100.00
709.	72.96	100.00
710.	74.00	100.00
711.	74.00	100.00
712.	77.73	100.00
713.	78.00	100.00
714.	77.50	100.00
715.	76.00	100.00
716.	76.00	100.00
717.	76.00	100.00
718.	72.45	100.00
719.	71.79	100.00
720.	67.16	100.00
721.	72.70	100.00
722.	75.02	100.00
723.	73.34	100.00
724.	73.64	91.78
725.	74.00	31.21
726.	78.27	28.63
727.	80.00	17.05
728.	80.00	5.48
729.	80.01	MOTORING
730.	80.00	MOTORING
731.	80.00	63.93
732.	84.00	80.00
733.	85.43	82.34
734.	87.52	93.96
735.	84.00	100.00
736.	84.00	100.00
737.	84.00	91.32
738.	86.01	100.00
739.	86.73	100.00
740.	90.01	96.59
741.	91.44	90.00
742.	94.00	90.00
743.	95.63	81.87
744.	96.00	89.70
745.	100.00	98.72
746.	100.57	75.60
747.	102.00	50.00
748.	104.00	73.99
749.	104.00	90.00

RECORD (SEC)	RPM	BPOWER
750.	104.00	25.98
751.	103.71	20.00
752.	99.54	20.00
753.	98.00	20.00
754.	99.09	25.44
755.	98.60	65.08
756.	103.17	80.00
757.	100.01	80.00
758.	102.35	80.00
759.	104.00	73.38
760.	104.00	55.11
761.	101.42	30.62
762.	98.34	11.97
763.	57.65	MOTORING
764.	56.00	MOTORING
765.	57.45	MOTORING
766.	55.00	MOTORING
767.	55.00	MOTORING
768.	56.00	27.34
769.	56.00	40.00
770.	56.00	50.00
771.	56.00	45.66
772.	56.00	33.77
773.	56.00	40.00
774.	60.19	5.40
775.	62.00	MOTORING
776.	62.00	MOTORING
777.	62.00	41.64
778.	62.00	59.65
779.	62.00	75.21
780.	62.00	76.36
781.	62.00	80.00
782.	62.00	80.00
783.	62.00	80.00
784.	62.00	80.00
785.	61.17	80.00
786.	60.00	80.00
787.	60.00	87.38
788.	60.00	90.00
789.	60.00	90.00
790.	60.00	90.00
791.	60.00	90.00
792.	60.00	90.00
793.	60.00	83.17
794.	60.00	80.00
795.	60.00	89.37
796.	62.31	90.00
797.	64.00	86.88
798.	64.00	80.00
799.	64.00	80.00

Gasoline Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
A00.	64.0[illegible]	80.00	A50.	88.1[illegible]	100.00	900.	0.0	0.0	950.	3.33	41.68
A01.	64.0[illegible]	80.00	A51.	89.21	100.00	901.	0.0	0.0	951.	4.00	89.46
A02.	66.0[illegible]	70.00	A52.	95.76	100.00	902.	0.0	0.0	952.	13.76	55.60
A03.	66.[illegible]1	70.00	A53.	100.23	100.00	903.	0.0	0.0	953.	26.43	26.96
A04.	68.00	65.87	A54.	102.00	100.00	904.	0.0	0.0	954.	33.85	6.16
A05.	68.0[illegible]	60.00	A55.	104.59	100.00	905.	0.0	0.0	955.	35.00	MOTORING
A06.	68.0[illegible]	60.00	A56.	112.71	100.00	906.	0.0	0.0	956.	34.45	MOTORING
A07.	73.[illegible]1	86.55	A57.	113.01	100.00	907.	0.0	0.0	957.	34.00	MOTORING
A08.	74.0[illegible]	90.00	A58.	112.09	100.00	908.	0.0	0.0	958.	35.64	MOTORING
A09.	74.0[illegible]	90.00	A59.	104.00	MOTORING	909.	0.0	0.0	959.	32.99	27.39
A10.	73.2[illegible]	90.00	A60.	103.56	MOTORING	910.	0.0	0.0	960.	35.00	80.00
A11.	72.0[illegible]	84.86	A61.	102.75	MOTORING	911.	0.0	0.0	961.	41.63	74.37
A12.	73.34	73.29	A62.	102.96	MOTORING	912.	0.0	0.0	962.	60.41	26.76
A13.	74.0[illegible]	70.00	A63.	99.24	MOTORING	913.	0.0	0.0	963.	48.44	MOTORING
A14.	72.[illegible]3	70.00	A64.	94.61	MOTORING	914.	0.0	0.0	964.	43.86	MOTORING
A15.	71.7[illegible]	50.00	A65.	93.9[illegible]	MOTORING	915.	0.0	0.0	965.	40.3[illegible]	MOTORING
A16.	70.0[illegible]	50.00	A66.	92.32	MOTORING	916.	0.0	0.0	966.	38.50	4.01
A17.	70.00	50.00	A67.	93.36	MOTORING	917.	0.0	0.0	967.	35.0[illegible]	30.00
A18.	68.77	56.15	A68.	92.09	MOTORING	918.	0.0	0.0	968.	40.66	16.70
A19.	68.0[illegible]	60.00	A69.	90.73	MOTORING	919.	0.0	0.0	969.	43.64	26.45
A20.	69.00	60.00	A70.	88.42	MOTORING	920.	-1.7[illegible]	44.40	970.	45.96	MOTORING
A21.	68.[illegible]0	58.24	A71.	84.21	MOTORING	921.	0.0	85.35	971.	47.10	MOTORING
A22.	68.0[illegible]	40.00	A72.	82.00	10.00	922.	4.25	100.00	972.	49.24	MOTORING
A23.	68.[illegible]1	48.01	A73.	82.00	7.38	923.	27.47	100.00	973.	37.10	MOTORING
A24.	68.0[illegible]	60.00	A74.	82.00	MOTORING	924.	42.95	100.00	974.	35.00	MOTORING
A25.	68.0[illegible]	60.00	A75.	82.00	MOTORING	925.	45.79	100.00	975.	34.4[illegible]	MOTORING
A26.	68.00	60.00	A76.	68.73	48.69	926.	48.11	99.46	976.	32.1[illegible]	MOTORING
A27.	68.[illegible]3	60.00	A77.	54.00	70.00	927.	50.42	90.00	977.	31.67	MOTORING
A28.	68.0[illegible]	61.87	A78.	64.00	70.00	928.	52.74	75.23	978.	28.4[illegible]	13.89
A29.	68.0[illegible]	70.00	A79.	58.56	67.55	929.	54.00	50.00	979.	32.3[illegible]	40.00
A30.	69.0[illegible]	70.00	A80.	57.27	50.00	930.	44.42	8.96	980.	36.00	90.00
A31.	70.0[illegible]	70.00	A81.	54.46	50.00	931.	45.05	MOTORING	981.	41.6[illegible]	90.00
A32.	70.00	70.00	A82.	52.85	73.54	932.	46.00	9.99	982.	45.74	90.00
A33.	71.0[illegible]	70.00	A83.	50.33	90.00	933.	37.69	MOTORING	983.	49.95	80.00
A34.	70.00	70.00	A84.	48.02	90.00	934.	31.81	5.68	984.	49.10	80.00
A35.	70.0[illegible]	70.00	A85.	45.70	90.00	935.	22.94	35.29	985.	50.5[illegible]	62.97
A36.	70.00	70.00	A86.	43.38	97.76	936.	24.00	4.87	986.	45.99	34.95
A37.	71.[illegible]1	70.00	A87.	41.07	10.00	937.	20.86	MOTORING	987.	42.76	7.23
A38.	70.[illegible]0	62.41	A88.	18.74	10.00	938.	12.45	MOTORING	988.	35.12	MOTORING
A39.	76.0[illegible]	60.00	A89.	14.49	MOTORING	939.	6.00	MOTORING	989.	32.0[illegible]	67.92
A40.	76.00	100.00	A90.	12.13	MOTORING	940.	6.32	MOTORING	990.	35.53	62.55
A41.	76.92	100.00	A91.	5.45	MOTORING	941.	7.17	MOTORING	991.	40.57	68.60
A42.	80.75	100.00	A92.	0.0	0.0	942.	2.55	MOTORING	992.	44.77	48.85
A43.	82.31	100.00	A93.	0.0	0.0	943.	0.0	0.0	993.	32.00	80.00
A44.	81.4[illegible]	100.00	A94.	0.0	0.0	944.	0.0	0.0	994.	54.0[illegible]	80.00
A45.	80.0[illegible]	100.00	A95.	0.0	0.0	945.	0.0	0.0	995.	63.66	23.42
A46.	83.47	90.30	A96.	0.0	0.0	946.	0.0	10.11	996.	64.14	17.84
A47.	82.33	90.00	A97.	0.0	0.0	947.	4.32	46.40	997.	59.5[illegible]	3.76
A48.	85.34	93.31	A98.	0.0	0.0	948.	8.9[illegible]	45.17	998.	36.00	42.26
A49.	89.1[illegible]	100.00	A99.	0.0	0.0	949.	1.45	50.00	999.	39.09	30.00

Gasoline Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
1000.	40.0	30.00	1050.	2.06	MOTORING	1100.	-4.22	15.28	1150.	0.0	0.0
1001.	34.55	47.18	1051.	0.54	MOTORING	1101.	0.0	10.00	1151.	0.0	0.0
1002.	32.04	10.33	1052.	0.0	MOTORING	1102.	0.0	10.00	1152.	0.0	0.0
1003.	34.01	33.44	1053.	0.0	MOTORING	1103.	0.0	10.00	1153.	0.0	0.0
1004.	34.01	50.60	1054.	0.0	MOTORING	1104.	0.0	75.93	1154.	0.0	0.0
1005.	33.02	20.69	1055.	0.0	MOTORING	1105.	0.0	32.22	1155.	0.0	0.0
1006.	25.55	MOTORING	1056.	0.0	0.0	1106.	1.67	35.00	1156.	0.0	0.0
1007.	15.57	MOTORING	1057.	0.0	0.0	1107.	15.48	29.82	1157.	0.0	0.0
1008.	14.05	MOTORING	1058.	0.0	0.0	1108.	25.46	MOTORING	1158.	0.0	0.0
1009.	14.47	27.64	1059.	0.0	0.0	1109.	24.22	MOTORING	1159.	0.0	0.0
1010.	15.01	4.43	1060.	0.0	0.0	1110.	23.44	MOTORING	1160.	0.0	0.0
1011.	17.14	MOTORING	1061.	0.0	MOTORING	1111.	12.41	80.00	1161.	0.0	0.0
1012.	16.00	MOTORING	1062.	0.0	22.01	1112.	8.94	83.61	1162.	0.0	0.0
1013.	10.92	MOTORING	1063.	1.23	72.29	1113.	7.26	84.82	1163.	0.0	0.0
1014.	9.91	MOTORING	1064.	6.53	30.00	1114.	16.70	80.00	1164.	0.0	0.0
1015.	5.88	MOTORING	1065.	17.29	39.29	1115.	24.67	63.33	1165.	0.0	0.0
1016.	4.01	MOTORING	1066.	22.17	40.00	1116.	0.24	79.81	1166.	0.0	0.0
1017.	4.01	MOTORING	1067.	24.03	82.70	1117.	0.0	8.52	1167.	0.0	0.0
1018.	2.49	MOTORING	1068.	24.03	51.46	1118.	0.0	0.0			
1019.	0.82	MOTORING	1069.	24.03	MOTORING	1119.	0.0	0.0			
1020.	0.0	MOTORING	1070.	22.37	MOTORING	1120.	0.0	0.0			
1021.	0.0	MOTORING	1071.	22.00	MOTORING	1121.	0.0	0.0			
1022.	0.0	MOTORING	1072.	13.84	MOTORING	1122.	0.0	0.0			
1023.	0.0	MOTORING	1073.	10.00	MOTORING	1123.	0.0	0.0			
1024.	0.0	MOTORING	1074.	9.31	MOTORING	1124.	0.0	0.0			
1025.	0.0	10.00	1075.	3.94	MOTORING	1125.	0.0	0.0			
1026.	0.0	10.00	1076.	0.0	0.0	1126.	0.0	0.0			
1027.	0.0	29.02	1077.	0.0	0.0	1127.	0.0	0.0			
1028.	0.0	27.83	1078.	0.0	0.0	1128.	0.0	17.59			
1029.	0.0	7.34	1079.	0.0	0.0	1129.	0.0	19.63			
1030.	0.0	0.0	1080.	0.0	0.0	1130.	0.0	10.00			
1031.	0.0	0.0	1081.	0.0	0.0	1131.	0.0	10.00			
1032.	0.0	0.0	1082.	0.0	0.0	1132.	0.0	10.00			
1033.	0.0	0.0	1083.	0.0	0.0	1133.	0.0	3.34			
1034.	0.0	0.0	1084.	0.0	0.0	1134.	0.0	0.0			
1035.	0.0	0.0	1085.	0.0	0.0	1135.	0.0	0.0			
1036.	0.0	0.0	1086.	0.0	0.0	1136.	0.0	0.0			
1037.	0.0	0.0	1087.	0.0	0.0	1137.	0.0	0.0			
1038.	0.0	0.0	1088.	0.0	0.0	1138.	0.0	0.0			
1039.	0.0	0.0	1089.	0.0	0.0	1139.	0.0	0.0			
1040.	0.0	0.0	1090.	0.0	0.0	1140.	0.0	0.0			
1041.	2.00	0.0	1091.	0.0	0.0	1141.	0.0	0.0			
1042.	1.33	0.0	1092.	0.0	0.0	1142.	0.0	0.0			
1043.	0.0	0.0	1093.	0.0	0.0	1143.	0.0	0.0			
1044.	0.0	6.27	1094.	0.0	0.0	1144.	0.0	0.0			
1045.	0.0	2.16	1095.	0.0	0.0	1145.	0.0	0.0			
1046.	0.0	0.0	1096.	0.0	0.0	1146.	0.0	0.0			
1047.	0.0	0.0	1097.	0.0	0.0	1147.	0.0	0.0			
1048.	0.0	0.0	1098.	0.0	0.0	1148.	0.0	0.0			
1049.	0.84	MOTORING	1099.	-2.52	5.10	1149.	0.0	0.0			

Diesel Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
0.	0.0	0.0	50.	54.03	11.42	100.	0.0	0.0	150.	0.0	0.0
1.	0.0	0.0	51.	58.00	05.03	101.	0.0	0.0	151.	0.0	0.0
2.	0.0	0.0	52.	59.65	43.23	102.	0.0	0.0	152.	0.0	0.0
3.	0.0	0.0	53.	62.89	30.00	103.	0.0	0.0	153.	0.0	0.0
4.	0.0	0.0	54.	69.83	30.00	104.	0.0	0.0	154.	0.0	0.0
5.	0.0	0.0	55.	72.00	42.05	105.	0.0	0.0	155.	0.0	0.0
6.	0.0	0.0	56.	75.81	30.00	106.	0.0	0.0	156.	0.0	0.0
7.	0.0	0.0	57.	84.23	42.20	107.	0.0	0.0	157.	0.0	0.0
8.	0.0	0.0	58.	83.86	41.28	108.	0.0	0.0	158.	0.0	0.21
9.	0.0	0.0	59.	80.55	MOTORING	109.	0.0	0.0	159.	0.0	30.00
10.	0.0	0.0	60.	80.51	MOTORING	110.	0.0	0.0	160.	0.0	26.78
11.	0.0	0.0	61.	78.00	MOTORING	111.	0.0	0.0	161.	0.0	20.00
12.	0.0	0.0	62.	79.79	MOTORING	112.	0.0	0.0	162.	0.0	20.00
13.	0.0	0.0	63.	80.33	40.54	113.	0.0	0.0	163.	0.0	4.12
14.	0.0	0.0	64.	85.58	42.12	114.	0.0	0.0	164.	0.0	0.0
15.	0.0	0.0	65.	81.78	30.00	115.	0.0	0.0	165.	0.0	0.0
16.	0.0	0.0	66.	78.00	30.00	116.	0.0	0.0	166.	0.0	0.0
17.	0.0	0.0	67.	80.74	43.16	117.	0.0	0.0	167.	0.0	0.0
18.	0.0	0.0	68.	92.10	73.65	118.	0.0	0.0	168.	0.0	0.0
19.	0.0	0.0	69.	88.01	MOTORING	119.	0.0	0.0	169.	0.0	0.0
20.	0.0	0.0	70.	84.00	MOTORING	120.	0.0	0.0	170.	0.0	0.0
21.	0.0	0.0	71.	84.00	MOTORING	121.	0.0	0.0	171.	0.0	0.0
22.	0.0	0.0	72.	81.17	MOTORING	122.	0.0	0.0	172.	0.0	0.0
23.	0.0	0.0	73.	70.46	MOTORING	123.	0.0	0.0	173.	0.0	0.0
24.	0.0	0.0	74.	66.00	13.57	124.	0.0	0.0	174.	0.0	0.0
25.	0.0	3.67	75.	62.23	29.43	125.	0.0	0.0	175.	0.0	0.0
26.	0.0	47.69	76.	64.07	20.00	126.	0.0	0.0	176.	0.0	0.0
27.	3.11	59.41	77.	53.43	17.42	127.	0.0	0.0	177.	0.0	0.0
28.	9.14	84.54	78.	50.36	10.00	128.	0.0	0.0	178.	0.0	0.0
29.	15.52	80.00	79.	56.85	10.00	129.	1.77	MOTORING	179.	0.0	0.0
30.	33.49	80.00	80.	56.00	MOTORING	130.	1.60	MOTORING	180.	0.0	0.0
31.	37.91	79.29	81.	52.45	MOTORING	131.	0.0	MOTORING	181.	0.0	0.0
32.	31.20	38.25	82.	39.91	10.00	132.	0.0	0.0	182.	0.0	0.0
33.	21.94	26.87	83.	36.34	10.00	133.	2.14	9.28	183.	0.0	0.0
34.	30.01	15.10	84.	40.00	10.00	134.	3.05	0.0	184.	0.0	20.00
35.	22.24	16.47	85.	47.33	10.00	135.	0.0	0.0	185.	0.0	20.00
36.	14.61	28.05	86.	60.00	10.74	136.	0.0	0.0	186.	0.0	11.73
37.	20.01	20.38	87.	67.66	3.36	137.	0.0	0.0	187.	0.0	0.0
38.	18.33	MOTORING	88.	28.00	MOTORING	138.	0.0	0.0	188.	0.0	0.0
39.	6.53	MOTORING	89.	27.41	MOTORING	139.	0.0	0.0	189.	0.0	0.0
40.	13.82	MOTORING	90.	20.74	MOTORING	140.	0.0	0.0	190.	0.0	0.0
41.	23.53	MOTORING	91.	12.15	MOTORING	141.	0.0	0.0	191.	0.0	0.0
42.	17.51	MOTORING	92.	3.41	MOTORING	142.	0.0	0.0	192.	0.0	0.0
43.	14.13	62.52	93.	0.0	MOTORING	143.	0.0	0.0	193.	0.0	0.0
44.	16.36	59.36	94.	0.0	MOTORING	144.	0.0	0.0	194.	0.0	0.0
45.	27.77	60.00	95.	0.0	0.41	145.	0.0	0.0	195.	0.0	0.0
46.	37.53	63.74	96.	0.0	7.52	146.	0.0	0.0	196.	0.0	0.0
47.	47.35	75.36	97.	0.0	0.0	147.	0.0	5.51	197.	0.0	0.0
48.	54.77	80.00	98.	0.0	0.0	148.	0.0	11.34	198.	0.0	0.0
49.	57.70	80.00	99.	0.0	0.0	149.	0.0	0.0	199.	0.0	0.0

Diesel Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
200.	0.0	0.0	250.	23.05	30.97	300.	0.0	0.0	350.	0.0	0.0
201.	0.0	0.0	251.	18.20	27.34	301.	0.0	0.0	351.	0.0	0.0
202.	0.0	0.0	252.	12.84	23.71	302.	0.0	0.0	352.	0.0	0.0
203.	0.0	0.0	253.	10.10	28.95	303.	0.0	0.0	353.	0.0	0.0
204.	0.0	0.0	254.	3.73	28.95	304.	0.0	0.0	354.	0.0	0.0
205.	0.0	0.0	255.	1.49	24.28	305.	0.0	0.0	355.	0.0	0.0
206.	0.0	0.0	256.	0.0	0.0	306.	0.0	0.0	356.	0.0	0.0
207.	0.0	0.0	257.	0.0	0.0	307.	0.0	0.0	357.	0.0	0.0
208.	0.0	0.0	258.	0.0	0.0	308.	0.0	0.0	358.	0.0	0.0
209.	0.0	0.0	259.	0.0	0.0	309.	0.0	0.0	359.	0.0	0.0
210.	0.0	0.0	260.	0.0	0.0	310.	0.0	0.0	360.	0.0	0.0
211.	0.0	0.0	261.	0.0	0.0	311.	0.0	0.0	361.	0.0	0.0
212.	0.0	0.0	262.	0.0	0.0	312.	0.0	0.0	362.	0.0	0.0
213.	0.0	0.0	263.	0.0	24.47	313.	0.0	0.0	363.	0.0	0.0
214.	0.0	73.41	264.	0.0	17.16	314.	0.0	0.0	364.	0.0	0.0
215.	0.0	90.00	265.	0.0	6.20	315.	0.0	0.0	365.	0.0	0.0
216.	31.4	81.38	266.	0.0	10.00	316.	0.0	0.0	366.	0.0	0.0
217.	41.1	90.00	267.	0.0	10.00	317.	0.0	0.0	367.	0.0	0.0
218.	44.9	90.00	268.	0.0	0.0	318.	0.0	0.0	368.	0.0	0.0
219.	46.41	90.00	269.	0.0	0.0	319.	0.0	0.0	369.	0.0	0.0
220.	51.14	82.41	270.	0.0	0.0	320.	0.0	0.0	370.	0.0	0.0
221.	66.59	80.00	271.	0.0	0.0	321.	0.0	15.55	371.	0.0	0.0
222.	75.03	90.00	272.	0.0	0.0	322.	0.0	20.00	372.	0.0	0.0
223.	89.39	90.00	273.	0.0	0.0	323.	24.16	19.08	373.	0.0	0.0
224.	96.79	93.88	274.	0.0	0.0	324.	23.00	10.00	374.	0.0	0.0
225.	96.41	50.94	275.	0.0	0.0	325.	11.56	1.86	375.	0.0	0.0
226.	94.65	17.02	276.	0.0	0.0	326.	6.87	MOTORING	376.	0.0	0.0
227.	99.15	28.50	277.	0.0	0.0	327.	6.00	MOTORING	377.	0.0	29.59
228.	100.00	39.83	278.	0.0	0.0	328.	0.72	MOTORING	378.	-1.50	87.46
229.	100.03	30.00	279.	0.0	0.0	329.	0.0	0.0	379.	8.88	100.00
230.	100.00	26.64	280.	0.0	0.0	330.	0.0	0.0	380.	46.04	100.00
231.	100.94	20.00	281.	0.0	0.0	331.	0.0	0.0	381.	76.84	100.00
232.	100.71	20.00	282.	0.0	0.0	332.	0.0	0.0	382.	80.00	100.00
233.	100.00	36.06	283.	0.0	0.0	333.	0.0	0.0	383.	82.14	94.64
234.	98.1	40.00	284.	0.0	0.0	334.	0.0	0.0	384.	85.39	83.07
235.	95.77	30.00	285.	0.0	0.0	335.	0.0	0.0	385.	87.70	88.51
236.	94.55	32.75	286.	0.0	0.0	336.	0.0	0.0	386.	92.00	79.83
237.	96.85	35.68	287.	0.0	0.0	337.	0.0	0.0	387.	92.00	61.66
238.	99.1	30.00	288.	0.0	0.0	338.	0.0	0.0	388.	94.56	66.77
239.	100.0	44.93	289.	0.0	0.0	339.	0.0	0.0	389.	102.88	80.00
240.	101.81	50.00	290.	0.0	0.0	340.	0.0	0.0	390.	100.00	72.76
241.	96.54	MOTORING	291.	0.0	0.0	341.	0.0	0.0	391.	104.18	8.43
242.	83.55	MOTORING	292.	0.0	0.0	342.	0.0	0.0	392.	111.91	MOTORING
243.	56.0	MOTORING	293.	0.0	0.0	343.	0.0	0.0	393.	82.00	MOTORING
244.	45.0	MOTORING	294.	0.0	0.0	344.	0.0	0.0	394.	74.33	MOTORING
245.	41.7	45.18	295.	0.0	0.0	345.	0.0	0.0	395.	71.1	MOTORING
246.	38.31	78.47	296.	0.0	0.0	346.	0.0	0.0	396.	68.84	MOTORING
247.	35.4	80.00	297.	0.0	0.0	347.	0.0	0.0	397.	78.35	49.17
248.	31.3	80.00	298.	0.0	0.0	348.	0.0	0.0	398.	82.00	70.00
249.	25.3	80.00	299.	0.0	0.0	349.	0.0	0.0	399.	83.65	69.46

Diesel Engine Cycle

RECOR (SEC)	RPM	POWER	RECORD (SEC)	RPM	POWER	RECORD (SEC)	RPM	POWER	RECORD (SEC)	RPM	POWER
400.	92.13	60.00	450.	96.16	34.15	500.	93.71	80.00	550.	0.0	0.0
401.	97.41	60.00	451.	88.00	40.00	501.	94.87	80.00	551.	0.0	0.0
402.	94.93	60.00	452.	87.21	20.00	502.	103.56	80.00	552.	0.0	2.60
403.	100.74	60.00	453.	86.00	20.00	503.	101.23	41.89	553.	0.0	20.00
404.	103.65	43.17	454.	87.43	20.00	504.	95.45	24.85	554.	0.0	20.00
405.	104.0	10.04	455.	88.00	11.32	505.	98.00	50.00	555.	0.0	7.96
406.	90.62	20.00	456.	77.84	MOTORING	506.	99.74	50.00	556.	0.0	0.0
407.	83.47	20.00	457.	72.00	MOTORING	507.	106.21	46.82	557.	0.0	0.0
408.	81.10	15.29	458.	71.32	MOTORING	508.	110.34	MOTORING	558.	0.0	78.53
409.	80.01	10.00	459.	70.00	0.04	509.	98.55	MOTORING	559.	1.85	80.00
410.	76.35	MOTORING	460.	70.00	MOTORING	510.	70.93	MOTORING	560.	11.10	63.88
411.	74.11	MOTORING	461.	74.88	MOTORING	511.	67.27	MOTORING	561.	18.00	70.00
412.	71.50	MOTORING	462.	74.04	MOTORING	512.	60.95	MOTORING	562.	30.03	70.00
413.	70.34	MOTORING	463.	67.74	MOTORING	513.	48.03	MOTORING	563.	42.88	70.00
414.	74.01	MOTORING	464.	66.00	MOTORING	514.	52.31	MOTORING	564.	56.10	70.00
415.	83.67	1.45	465.	64.23	MOTORING	515.	54.00	MOTORING	565.	63.33	66.52
416.	80.54	17.30	466.	62.03	MOTORING	516.	55.27	MOTORING	566.	70.66	59.94
417.	78.21	11.13	467.	55.96	MOTORING	517.	78.00	MOTORING	567.	72.98	80.00
418.	78.43	19.55	468.	54.03	MOTORING	518.	57.61	MOTORING	568.	77.87	86.46
419.	84.47	24.14	469.	66.43	MOTORING	519.	42.57	MOTORING	569.	85.03	90.00
420.	72.15	80.00	470.	75.21	70.00	520.	38.81	MOTORING	570.	90.00	90.00
421.	74.1	74.83	471.	86.00	24.53	521.	22.37	MOTORING	571.	92.23	100.00
422.	90.14	16.04	472.	86.00	24.58	522.	3.32	MOTORING	572.	90.00	100.00
423.	74.04	MOTORING	473.	88.31	MOTORING	523.	0.0	0.0	573.	94.86	100.00
424.	68.02	MOTORING	474.	90.00	MOTORING	524.	-1.45	36.39	574.	98.00	100.00
425.	68.53	MOTORING	475.	105.43	MOTORING	525.	-0.23	5.75	575.	97.45	100.00
426.	54.34	MOTORING	476.	74.00	MOTORING	526.	0.0	0.0	576.	104.84	100.00
427.	63.54	MOTORING	477.	73.34	MOTORING	527.	0.0	0.0	577.	110.00	83.92
428.	70.00	2.34	478.	71.02	10.00	528.	0.0	0.0	578.	104.77	MOTORING
429.	73.13	17.76	479.	76.46	29.38	529.	0.0	0.0	579.	87.50	MOTORING
430.	72.13	MOTORING	480.	81.61	40.00	530.	0.0	0.0	580.	90.00	0.0
431.	67.27	MOTORING	481.	78.16	30.39	531.	0.0	0.0	581.	91.31	MOTORING
432.	36.03	MOTORING	482.	74.13	25.46	532.	0.0	0.0	582.	81.84	MOTORING
433.	20.75	MOTORING	483.	90.00	0.0	533.	0.0	0.0	583.	65.99	MOTORING
434.	11.49	MOTORING	484.	90.87	0.0	534.	0.0	0.0	584.	53.65	MOTORING
435.	-2.02	MOTORING	485.	92.00	MOTORING	535.	0.0	0.0	585.	60.73	MOTORING
436.	-0.73	MOTORING	486.	93.30	MOTORING	536.	0.0	0.0	586.	57.05	MOTORING
437.	4.57	60.00	487.	94.00	MOTORING	537.	0.0	0.0	587.	53.47	MOTORING
438.	30.33	61.93	488.	94.13	MOTORING	538.	0.0	0.0	588.	50.42	MOTORING
439.	67.17	63.00	489.	88.36	MOTORING	539.	0.0	0.0	589.	44.31	MOTORING
440.	85.03	39.85	490.	83.25	MOTORING	540.	0.0	0.0	590.	37.52	37.91
441.	84.31	30.00	491.	82.00	MOTORING	541.	0.0	0.0	591.	33.42	20.00
442.	91.52	30.00	492.	83.54	33.47	542.	0.0	0.0	592.	31.15	20.00
443.	97.80	10.40	493.	92.43	30.39	543.	0.0	0.0	593.	25.85	20.00
444.	97.73	1.37	494.	84.00	40.00	544.	0.0	MOTORING	594.	22.13	20.00
445.	95.10	10.00	495.	84.47	40.00	545.	0.0	0.0	595.	9.31	MOTORING
446.	97.01	0.58	496.	71.90	33.22	546.	-0.75	MOTORING	596.	0.0	0.0
447.	95.41	MOTORING	497.	70.49	30.21	547.	-0.50	MOTORING	597.	0.0	0.0
448.	85.27	20.38	498.	82.00	0.0	548.	4.00	MOTORING	598.	0.0	0.0
449.	87.99	30.76	499.	89.20	0.0	549.	0.62	MOTORING	599.	0.0	0.0

Diesel Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
600.	0.0	0.0	650.	88.00	24.45	700.	81.70	MOTORING	750.	94.5[illegible]	87.05
601.	0.0	0.0	651.	88.00	20.00	701.	85.10	MOTORING	751.	96.00	57.40
602.	0.0	0.0	652.	88.00	20.00	702.	84.52	MOTORING	752.	96.00	42.19
603.	0.0	0.0	653.	90.00	20.00	703.	82.21	MOTORING	753.	96.00	42.33
604.	0.0	0.0	654.	89.63	20.00	704.	79.89	MOTORING	754.	96.00	40.00
605.	0.0	0.0	655.	88.68	20.00	705.	77.58	MOTORING	755.	96.00	38.37
606.	2.32	6.30	656.	90.00	20.00	706.	76.00	6.31	756.	96.00	12.83
607.	10.37	17.87	657.	90.00	20.00	707.	79.16	0.0	757.	96.00	MOTORING
608.	13.89	20.00	658.	91.63	21.46	708.	75.16	27.36	758.	96.00	MOTORING
609.	20.2[illegible]	20.00	659.	92.00	20.00	709.	72.00	40.00	759.	96.00	MOTORING
610.	24.07	22.59	660.	90.00	21.29	710.	72.00	40.00	760.	97.74	7.37
611.	33.33	17.50	661.	89.43	22.86	711.	74.00	38.44	761.	100.0[illegible]	19.74
612.	40.31	MOTORING	662.	87.11	100.00	712.	74.00	30.00	762.	102.00	11.83
613.	47.[illegible]	MOTORING	663.	86.00	100.00	713.	74.00	30.00	763.	102.00	26.81
614.	66.00	7.78	664.	86.00	100.00	714.	74.00	36.28	764.	103.00	49.96
615.	68.00	10.93	665.	89.65	100.00	715.	72.43	47.86	765.	104.00	60.00
616.	67.[illegible]	32.04	666.	90.00	49.27	716.	68.23	59.43	766.	102.37	60.00
617.	66.0[illegible]	40.00	667.	90.46	20.00	717.	73.80	50.00	767.	103.94	60.00
618.	67.0[illegible]	40.00	668.	92.78	20.00	718.	72.52	50.00	768.	104.00	40.00
619.	68.0[illegible]	40.00	669.	95.09	20.00	719.	74.00	45.85	769.	104.00	25.75
620.	68.00	48.33	670.	100.22	32.97	720.	72.85	57.18	770.	103.12	MOTORING
621.	75.33	99.53	671.	102.00	20.00	721.	76.38	62.70	771.	100.80	MOTORING
622.	74.0[illegible]	100.00	672.	102.06	70.18	722.	81.55	60.00	772.	100.00	MOTORING
623.	74.0[illegible]	100.00	673.	102.09	80.60	723.	80.10	60.00	773.	101.83	44.88
624.	77.07	100.00	674.	97.34	30.07	724.	83.60	60.00	774.	102.00	36.40
625.	76.0[illegible]	100.00	675.	87.02	MOTORING	725.	83.44	56.40	775.	102.00	MOTORING
626.	76.00	100.00	676.	86.00	MOTORING	726.	86.00	50.00	776.	102.00	MOTORING
627.	76.0[illegible]	100.00	677.	73.12	22.19	727.	87.35	50.00	777.	100.91	MOTORING
628.	75.63	100.00	678.	75.77	39.62	728.	86.34	50.00	778.	101.40	MOTORING
629.	73.00	97.50	679.	75.76	48.80	729.	86.00	40.11	779.	100.24	MOTORING
630.	76.81	90.00	680.	75.11	47.23	730.	88.29	61.47	780.	97.97	MOTORING
631.	80.25	90.00	681.	78.00	44.34	731.	88.78	63.92	781.	96.00	MOTORING
632.	83.44	90.00	682.	80.37	40.00	732.	86.96	50.00	782.	96.00	10.00
633.	84.00	98.74	683.	77.51	47.49	733.	86.76	50.00	783.	96.00	0.23
634.	84.00	100.00	684.	81.46	50.00	734.	87.55	42.24	784.	95.00	MOTORING
635.	83.81	100.00	685.	82.13	39.36	735.	88.00	49.34	785.	96.00	MOTORING
636.	82.00	100.00	686.	84.00	27.79	736.	86.00	50.91	786.	94.08	MOTORING
637.	83.32	94.91	687.	84.00	16.21	737.	86.00	67.45	787.	76.00	MOTORING
638.	86.67	90.00	688.	84.00	15.16	738.	86.00	81.88	788.	77.45	MOTORING
639.	89.55	90.00	689.	85.30	26.43	739.	87.13	70.00	789.	71.67	28.96
640.	90.00	99.81	690.	86.00	30.00	740.	89.44	77.21	790.	67.18	80.00
641.	89.45	100.00	691.	86.00	30.08	741.	91.76	88.78	791.	66.56	87.48
642.	85.0[illegible]	100.00	692.	85.57	30.00	742.	90.07	89.65	792.	71.43	90.00
643.	86.0[illegible]	95.47	693.	84.05	30.00	743.	92.00	80.00	793.	74.1[illegible]	90.00
644.	87.22	90.00	694.	85.00	35.20	744.	92.70	80.00	794.	73.56	92.20
645.	88.01	90.00	695.	87.24	30.00	745.	94.00	80.00	795.	74.75	100.00
646.	88.0[illegible]	80.74	696.	88.00	22.05	746.	94.00	80.00	796.	77.07	94.65
647.	88.0[illegible]	79.17	697.	86.03	MOTORING	747.	94.00	80.00	797.	79.3	83.08
648.	88.01	77.21	698.	83.74	MOTORING	748.	94.00	80.00	798.	80.00	71.51
649.	88.0[illegible]	100.00	699.	81.47	MOTORING	749.	94.00	81.37	799.	80.01	69.93

Diesel Engine Cycle

RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
800.	82.34	58.35	850.	104.00	0.50	900.	0.0	0.0	950.	54.77	80.00
801.	84.00	50.00	851.	103.53	11.87	901.	0.0	0.0	951.	57.70	80.00
802.	84.00	59.53	852.	100.62	13.12	902.	0.0	0.0	952.	54.03	79.92
803.	84.00	74.36	853.	98.00	5.01	903.	0.0	0.0	953.	58.00	65.03
804.	84.00	80.00	854.	96.84	10.00	904.	0.0	0.0	954.	58.65	43.23
805.	84.00	70.49	855.	96.00	MOTORING	905.	0.0	0.0	955.	62.88	50.00
806.	82.00	80.00	856.	96.00	MOTORING	906.	0.0	0.0	956.	59.83	50.00
807.	81.47	82.66	857.	96.00	MOTORING	907.	0.0	0.0	957.	72.00	42.05
808.	80.00	90.00	858.	95.43	MOTORING	908.	0.0	0.0	958.	75.81	40.00
809.	77.53	90.00	859.	94.00	MOTORING	909.	0.0	0.0	959.	84.22	42.20
810.	74.52	75.24	860.	94.00	MOTORING	910.	0.0	0.0	960.	83.86	41.28
811.	77.53	78.96	861.	95.53	5.18	911.	0.0	0.0	961.	80.55	MOTORING
812.	81.84	80.00	862.	97.83	MOTORING	912.	0.0	0.0	962.	80.51	MOTORING
813.	80.42	80.00	863.	98.00	MOTORING	913.	0.0	0.0	963.	78.00	MOTORING
814.	82.00	83.64	864.	98.00	MOTORING	914.	0.0	0.0	964.	74.70	MOTORING
815.	83.00	79.50	865.	97.22	MOTORING	915.	0.0	0.0	965.	80.33	30.54
816.	84.00	70.00	866.	96.00	5.15	916.	0.0	0.0	966.	85.54	42.12
817.	84.00	61.60	867.	96.00	12.98	917.	0.0	0.0	967.	81.74	50.00
818.	84.0	50.33	868.	96.00	10.00	918.	0.0	0.0	968.	78.00	50.00
819.	86.00	60.00	869.	95.94	10.00	919.	0.0	0.0	969.	80.74	43.15
820.	85.00	60.00	870.	92.00	10.00	920.	0.0	0.0	970.	92.10	73.65
821.	85.00	69.39	871.	92.00	10.00	921.	0.0	0.0	971.	84.01	MOTORING
822.	88.51	73.73	872.	92.94	14.59	922.	0.0	0.0	972.	84.00	MOTORING
823.	88.43	70.00	873.	94.00	13.54	923.	0.0	0.0	973.	84.00	MOTORING
824.	88.00	70.00	874.	90.79	12.12	924.	0.0	0.0	974.	81.17	MOTORING
825.	94.00	70.93	875.	88.08	10.40	925.	0.0	0.0	975.	78.45	MOTORING
826.	94.51	80.00	876.	86.23	10.00	926.	0.0	0.0	976.	66.00	13.57
827.	95.17	80.00	877.	88.00	12.75	927.	0.0	3.67	977.	62.23	29.43
828.	95.14	80.00	878.	87.14	14.32	928.	0.0	47.69	978.	64.00	20.00
829.	94.34	80.00	879.	84.82	10.00	929.	3.11	59.41	979.	63.48	17.42
830.	94.00	80.00	880.	82.51	10.00	930.	9.09	84.54	980.	61.34	10.00
831.	94.00	77.84	881.	82.00	10.00	931.	15.82	80.00	981.	56.85	10.00
832.	94.00	81.99	882.	82.12	10.00	932.	33.49	80.00	982.	54.00	MOTORING
833.	94.00	83.57	883.	83.13	15.64	933.	37.93	79.29	983.	52.45	MOTORING
834.	94.00	80.28	884.	80.00	20.00	934.	31.20	38.25	984.	39.91	10.00
835.	94.00	83.24	885.	84.26	21.45	935.	21.94	26.67	985.	30.3	10.00
836.	94.00	76.57	886.	86.62	20.21	936.	30.00	15.10	986.	30.00	10.00
837.	94.00	89.86	887.	84.31	20.60	937.	22.23	16.47	987.	27.93	10.00
838.	94.24	90.00	888.	81.93	7.46	938.	19.61	28.05	988.	25.00	16.74
839.	97.00	87.00	889.	79.30	1.21	939.	20.00	20.38	989.	27.66	3.36
840.	102.91	80.00	890.	75.34	19.96	940.	18.33	MOTORING	990.	24.00	MOTORING
841.	104.00	73.85	891.	73.05	20.00	941.	6.55	MOTORING	991.	27.41	MOTORING
842.	104.00	62.28	892.	70.73	8.45	942.	15.42	MOTORING	992.	21.95	MOTORING
843.	104.00	69.29	893.	68.43	MOTORING	943.	23.63	MOTORING	993.	12.1	MOTORING
844.	105.00	70.00	894.	67.15	5.45	944.	17.51	MOTORING	994.	3.81	MOTORING
845.	106.00	62.70	895.	35.73	10.00	945.	14.19	62.52	995.	0.0	MOTORING
846.	106.00	40.00	896.	32.95	7.58	946.	10.84	69.36	996.	0.0	MOTORING
847.	104.53	40.00	897.	29.15	MOTORING	947.	27.77	60.00	997.	0.0	0.91
848.	104.00	32.85	898.	16.47	MOTORING	948.	37.03	63.79	998.	0.0	7.52
849.	104.00	30.00	899.	2.14	MOTORING	949.	47.36	75.36	999.	0.0	0.0

Diesel Engine Cycle

RECOR (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER	RECORD (SEC)	%RPM	%POWER
1000.	0.0	0.0	1050.	0.0	11.34	1100.	0.0	0.0	1150.	31.0	80.00
1001.	0.0	0.0	1051.	0.0	0.0	1101.	0.0	0.0	1151.	25.36	80.00
1002.	0.0	0.0	1052.	0.0	0.0	1102.	0.0	0.0	1152.	23.0	60.97
1003.	0.0	0.0	1053.	0.0	0.0	1103.	0.0	0.0	1153.	18.20	27.34
1004.	0.0	0.0	1054.	0.0	0.0	1104.	0.0	0.0	1154.	12.84	43.71
1005.	0.0	0.0	1055.	0.0	0.0	1105.	0.0	0.0	1155.	10.10	68.95
1006.	0.0	0.0	1056.	0.0	0.0	1106.	0.0	0.0	1156.	3.7	68.95
1007.	0.0	0.0	1057.	0.0	0.0	1107.	0.0	0.0	1157.	1.4	44.28
1008.	0.0	0.0	1058.	0.0	0.0	1108.	0.0	0.0	1158.	0.0	0.0
1009.	0.0	0.0	1059.	0.0	0.0	1109.	0.0	0.0	1159.	0.0	0.0
1010.	0.0	0.0	1060.	0.0	0.21	1110.	0.0	0.0	1160.	0.0	0.0
1011.	0.0	0.0	1061.	0.0	10.00	1111.	0.0	0.0	1161.	0.0	0.0
1012.	0.0	0.0	1062.	0.0	25.78	1112.	0.0	0.0	1162.	0.0	0.0
1013.	0.0	0.0	1063.	0.0	20.00	1113.	0.0	0.0	1163.	0.0	0.0
1014.	0.0	0.0	1064.	0.0	20.00	1114.	0.0	0.0	1164.	0.0	0.0
1015.	0.0	0.0	1065.	0.0	4.12	1115.	0.0	0.0	1165.	0.0	24.97
1016.	0.0	0.0	1066.	0.0	0.0	1116.	0.0	73.41	1166.	0.0	17.16
1017.	0.0	0.0	1067.	0.0	0.0	1117.	0.0	90.00	1167.	0.0	6.20
1018.	0.0	0.0	1068.	0.0	0.0	1118.	31.30	81.30	1168.	0.0	10.00
1019.	0.0	0.0	1069.	0.0	0.0	1119.	41.15	90.00	1169.	0.0	10.00
1020.	0.0	0.0	1070.	0.0	0.0	1120.	44.00	90.00	1170.	0.0	0.0
1021.	0.0	0.0	1071.	0.0	0.0	1121.	46.41	90.00	1171.	0.0	0.0
1022.	0.0	0.0	1072.	0.0	0.0	1122.	51.04	82.41	1172.	0.0	0.0
1023.	0.0	0.0	1073.	0.0	0.0	1123.	66.66	80.00	1173.	0.0	0.0
1024.	0.0	0.0	1074.	0.0	0.0	1124.	75.03	90.00	1174.	0.0	0.0
1025.	0.0	0.0	1075.	0.0	0.0	1125.	89.85	90.00	1175.	0.0	0.0
1026.	0.0	0.0	1076.	0.0	0.0	1126.	96.78	93.88	1176.	0.0	0.0
1027.	0.0	0.0	1077.	0.0	0.0	1127.	96.91	50.94	1177.	0.0	0.0
1028.	0.0	0.0	1078.	0.0	0.0	1128.	94.60	17.02	1178.	0.0	0.0
1029.	0.0	0.0	1079.	0.0	0.0	1129.	99.15	28.60	1179.	0.0	0.0
1030.	0.0	0.0	1080.	0.0	0.0	1130.	100.00	49.83	1180.	0.0	0.0
1031.	1.77	MOTORING	1081.	0.0	0.0	1131.	100.00	30.00	1181.	0.0	0.0
1032.	1.50	MOTORING	1082.	0.0	0.0	1132.	100.00	26.69	1182.	0.0	0.0
1033.	0.0	MOTORING	1083.	0.0	0.0	1133.	100.98	20.00	1183.	0.0	0.0
1034.	0.0	0.0	1084.	0.0	0.0	1134.	100.71	20.00	1184.	0.0	0.0
1035.	2.14	9.24	1085.	0.0	0.0	1135.	100.00	36.06	1185.	0.0	0.0
1036.	3.08	0.0	1086.	0.0	20.00	1136.	96.16	40.00	1186.	0.0	0.0
1037.	0.0	0.0	1087.	0.0	20.00	1137.	95.77	30.00	1187.	0.0	0.0
1038.	0.0	0.0	1088.	0.0	11.73	1138.	94.55	32.75	1188.	0.0	0.0
1039.	0.0	0.0	1089.	0.0	0.0	1139.	96.86	35.68	1189.	0.0	0.0
1040.	0.0	0.0	1090.	0.0	0.0	1140.	99.15	30.00	1190.	0.0	0.0
1041.	0.0	0.0	1091.	0.0	0.0	1141.	100.00	44.93	1191.	0.0	0.0
1042.	0.0	0.0	1092.	0.0	0.0	1142.	101.81	50.00	1192.	0.0	0.0
1043.	0.0	0.0	1093.	0.0	0.0	1143.	86.54	MOTORING	1193.	0.0	0.0
1044.	0.0	0.0	1094.	0.0	0.0	1144.	63.56	MOTORING	1194.	0.0	0.0
1045.	0.0	0.0	1095.	0.0	0.0	1145.	56.00	MOTORING	1195.	0.0	0.0
1046.	0.0	0.0	1096.	0.0	0.0	1146.	46.00	MOTORING	1196.	0.0	0.0
1047.	0.0	0.0	1097.	0.0	0.0	1147.	41.85	45.14	1197.	0.0	0.0
1048.	0.0	0.0	1098.	0.0	0.0	1148.	38.31	78.47	1198.	0.0	0.0
1049.	0.0	5.51	1099.	0.0	0.0	1149.	35.99	80.00	1199.	0.0	0.0

APPENDIX III

Finalized Transient Chassis Cycle

Chassis Cycle (Gasoline and Diesel)

RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)
0.	0.0	50.	12.26	100.	31.01	150.	0.0	200.	0.0	250.	0.0	300.	0.24	350.	12.00	400.	19.00	450.	32.85
1.	0.0	51.	13.29	101.	31.00	151.	0.0	201.	0.0	251.	0.0	301.	0.60	351.	11.73	401.	18.86	451.	33.01
2.	0.0	52.	14.56	102.	31.62	152.	0.0	202.	0.0	252.	0.0	302.	0.0	352.	11.00	402.	18.29	452.	34.00
3.	0.0	53.	15.20	103.	33.00	153.	0.0	203.	4.15	253.	0.0	303.	1.42	353.	11.00	403.	19.00	453.	33.68
4.	0.0	54.	15.76	104.	32.37	154.	0.0	204.	5.00	254.	0.0	304.	2.00	354.	11.00	404.	19.61	454.	32.52
5.	0.0	55.	17.00	105.	30.43	155.	0.0	205.	6.00	255.	0.0	305.	3.08	355.	11.90	405.	20.00	455.	32.00
6.	0.0	56.	17.00	106.	30.00	156.	0.0	206.	6.00	256.	0.0	306.	5.63	356.	12.49	406.	20.00	456.	32.00
7.	0.0	57.	17.23	107.	30.00	157.	0.0	207.	5.30	257.	0.0	307.	4.00	357.	10.36	407.	20.00	457.	32.95
8.	0.0	58.	16.77	108.	30.51	158.	0.0	208.	4.14	258.	0.0	308.	4.00	358.	7.26	408.	20.00	458.	33.00
9.	0.0	59.	20.54	109.	32.41	159.	0.0	209.	1.96	259.	0.0	309.	3.34	359.	4.95	409.	20.00	459.	33.00
10.	0.0	60.	17.60	110.	33.00	160.	0.0	210.	0.0	260.	0.0	310.	1.37	360.	4.68	410.	19.45	460.	33.42
11.	0.0	61.	18.14	111.	32.27	161.	0.0	211.	0.0	261.	0.0	311.	1.00	361.	6.58	411.	20.42	461.	34.00
12.	0.0	62.	17.98	112.	32.00	162.	0.0	212.	0.0	262.	0.0	312.	0.0	362.	8.00	412.	21.87	462.	34.74
13.	0.0	63.	17.00	113.	31.04	163.	0.0	213.	0.0	263.	0.0	313.	0.0	363.	7.84	413.	20.97	463.	35.00
14.	0.0	64.	16.34	114.	32.20	164.	0.0	214.	0.0	264.	0.0	314.	0.0	364.	7.00	414.	20.37	464.	35.00
15.	0.0	65.	15.00	115.	33.36	165.	0.0	215.	0.0	265.	0.0	315.	0.0	365.	6.53	415.	22.00	465.	35.00
16.	0.0	66.	13.00	116.	34.00	166.	0.0	216.	0.0	266.	0.0	316.	0.0	366.	7.49	416.	22.00	466.	35.00
17.	0.0	67.	13.00	117.	34.00	167.	0.0	217.	0.0	267.	0.0	317.	0.0	367.	10.57	417.	22.66	467.	35.00
18.	0.0	68.	13.95	118.	34.00	168.	0.0	218.	0.0	268.	0.0	318.	0.0	368.	11.00	418.	23.00	468.	35.00
19.	0.0	69.	12.35	119.	33.01	169.	0.0	219.	0.0	269.	0.0	319.	0.23	369.	10.10	419.	23.97	469.	35.84
20.	0.0	70.	13.24	120.	31.86	170.	0.0	220.	0.0	270.	0.0	320.	1.39	370.	10.74	420.	25.51	470.	37.99
21.	0.0	71.	14.27	121.	30.10	171.	0.0	221.	0.0	271.	0.0	321.	2.00	371.	10.42	421.	29.00	471.	38.00
22.	0.0	72.	12.54	122.	26.17	172.	0.0	222.	0.0	272.	0.0	322.	4.11	372.	11.00	422.	29.00	472.	37.69
23.	0.0	73.	12.25	123.	23.34	173.	0.0	223.	0.0	273.	0.0	323.	5.00	373.	12.45	423.	29.00	473.	38.41
24.	0.0	74.	9.28	124.	21.46	174.	0.51	224.	0.0	274.	0.0	324.	6.02	374.	14.77	424.	30.51	474.	39.37
25.	0.19	75.	8.00	125.	17.28	175.	0.33	225.	0.0	275.	0.0	325.	7.18	375.	14.09	425.	31.00	475.	39.00
26.	1.00	76.	8.00	126.	15.83	176.	0.0	226.	0.0	276.	0.0	326.	7.33	376.	16.20	426.	30.00	476.	39.00
27.	1.51	77.	8.38	127.	13.76	177.	0.0	227.	0.0	277.	0.0	327.	6.49	377.	17.00	427.	30.00	477.	38.10
28.	2.65	78.	9.53	128.	12.60	178.	0.0	228.	0.0	278.	0.0	328.	7.00	378.	17.00	428.	30.00	478.	39.00
29.	4.64	79.	10.69	129.	10.33	179.	0.0	229.	0.0	279.	0.0	329.	7.00	379.	17.00	429.	30.54	479.	39.41
30.	6.96	80.	11.00	130.	8.28	180.	0.0	230.	0.0	280.	0.0	330.	7.00	380.	17.00	430.	31.00	480.	40.57
31.	8.88	81.	9.00	131.	5.38	181.	0.0	231.	0.48	281.	0.0	331.	7.00	381.	15.02	431.	31.86	481.	41.73
32.	7.71	82.	9.00	132.	2.91	182.	0.0	232.	1.54	282.	0.0	332.	7.00	382.	15.71	432.	31.00	482.	42.00
33.	7.45	83.	9.32	133.	0.0	183.	0.0	233.	0.41	283.	0.0	333.	7.43	383.	14.00	433.	31.17	483.	41.92
34.	9.22	84.	10.00	134.	0.0	184.	0.0	234.	0.0	284.	0.0	334.	8.00	384.	14.92	434.	32.33	484.	40.00
35.	10.01	85.	9.36	135.	0.0	185.	0.0	235.	0.0	285.	0.0	335.	8.00	385.	15.38	435.	33.00	485.	40.00
36.	9.03	86.	9.00	136.	0.0	186.	0.0	236.	0.0	286.	0.0	336.	7.09	386.	15.78	436.	33.00	486.	39.49
37.	10.04	87.	8.95	137.	0.0	187.	0.0	237.	0.0	287.	0.0	337.	11.06	387.	16.00	437.	33.80	487.	37.66
38.	11.24	88.	14.33	138.	0.0	188.	0.0	238.	0.0	288.	0.0	338.	12.89	388.	16.00	438.	34.00	488.	37.00
39.	12.74	89.	17.53	139.	0.0	189.	0.0	239.	0.0	289.	0.0	339.	14.49	389.	16.25	439.	35.12	489.	36.01
40.	14.01	90.	19.42	140.	0.0	190.	0.0	240.	0.0	290.	0.0	340.	11.46	390.	17.41	440.	36.00	490.	34.86
41.	12.54	91.	20.00	141.	0.0	191.	0.0	241.	0.0	291.	0.0	341.	13.08	391.	18.56	441.	36.00	491.	33.70
42.	12.87	92.	21.74	142.	0.0	192.	0.0	242.	0.0	292.	0.0	342.	16.55	392.	19.00	442.	34.82	492.	32.54
43.	13.00	93.	21.00	143.	0.0	193.	0.0	243.	0.0	293.	0.0	343.	16.00	393.	19.48	443.	33.25	493.	29.54
44.	13.00	94.	21.11	144.	0.0	194.	0.0	244.	0.0	294.	0.0	344.	15.34	394.	21.00	444.	32.09	494.	26.46
45.	13.62	95.	23.84	145.	0.0	195.	0.0	245.	0.0	295.	0.0	345.	12.32	395.	21.00	445.	32.00	495.	22.28
46.	15.00	96.	27.00	146.	0.0	196.	0.0	246.	0.0	296.	0.0	346.	13.00	396.	21.00	446.	32.00	496.	19.91
47.	15.00	97.	27.00	147.	0.0	197.	0.13	247.	0.0	297.	0.0	347.	13.00	397.	20.49	447.	32.00	497.	18.76
48.	13.37	98.	27.05	148.	0.0	198.	0.71	248.	0.0	298.	0.0	348.	13.00	398.	20.00	448.	32.00	498.	17.60
49.	12.03	99.	32.52	149.	0.0	199.	0.0	249.	0.0	299.	0.0	349.	15.86	399.	19.18	449.	32.00	499.	16.44

Chassis Cycle (Gasoline and Diesel)

RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)
500.	14.57	550.	12.73	600.	46.00	650.	50.47	700.	55.00	750.	56.00	800.	10.71	850.	13.00	900.	21.11	950.	0.0
501.	13.13	551.	14.78	601.	46.00	651.	51.00	701.	54.50	751.	55.63	801.	6.08	851.	13.68	901.	23.84	951.	0.0
502.	11.47	552.	16.05	602.	46.42	652.	51.00	702.	54.66	752.	55.00	802.	2.61	852.	15.00	902.	27.00	952.	0.0
503.	10.81	553.	17.41	603.	47.00	653.	51.00	703.	55.00	753.	55.00	803.	1.45	853.	15.00	903.	27.00	953.	0.0
504.	9.31	554.	19.72	604.	47.00	654.	51.00	704.	54.03	754.	55.00	804.	0.30	854.	13.37	904.	29.05	954.	0.0
505.	7.51	555.	21.52	605.	47.00	655.	51.00	705.	54.00	755.	55.00	805.	0.0	855.	12.03	905.	32.52	955.	0.0
506.	6.34	556.	23.35	606.	47.00	656.	51.42	706.	54.00	756.	55.00	806.	0.0	856.	12.26	906.	31.01	956.	0.0
507.	4.37	557.	24.83	607.	47.00	657.	52.00	707.	54.00	757.	55.00	807.	0.0	857.	14.29	907.	31.00	957.	0.0
508.	3.03	558.	25.99	608.	47.00	658.	52.00	708.	54.00	758.	55.00	808.	0.0	858.	14.56	908.	31.62	958.	0.0
509.	1.87	559.	27.15	609.	47.04	659.	52.00	709.	54.00	759.	55.00	809.	0.0	859.	15.20	909.	33.00	959.	0.0
510.	0.71	560.	28.31	610.	49.00	660.	52.00	710.	54.00	760.	54.22	810.	0.0	860.	16.76	910.	32.37	960.	0.0
511.	0.0	561.	29.46	611.	49.33	661.	52.20	711.	54.00	761.	54.00	811.	0.0	861.	17.00	911.	30.43	961.	0.0
512.	0.0	562.	30.62	612.	49.51	662.	53.00	712.	54.00	762.	54.00	812.	0.0	862.	17.00	912.	30.00	962.	0.0
513.	0.0	563.	31.78	613.	49.00	663.	53.00	713.	54.77	763.	54.00	813.	0.0	863.	17.23	913.	30.00	963.	0.0
514.	0.0	564.	32.94	614.	49.00	664.	53.00	714.	56.00	764.	54.00	814.	0.0	864.	18.77	914.	30.51	964.	0.0
515.	0.0	565.	34.14	615.	49.00	665.	53.00	715.	56.00	765.	54.00	815.	0.0	865.	20.54	915.	32.41	965.	0.0
516.	0.0	566.	35.25	616.	49.00	666.	53.00	716.	56.00	766.	54.00	816.	0.0	866.	19.60	916.	33.00	966.	0.0
517.	0.0	567.	37.41	617.	48.72	667.	53.00	717.	56.02	767.	54.00	817.	0.0	867.	18.14	917.	32.27	967.	0.0
518.	0.0	568.	38.56	618.	48.47	668.	53.00	718.	57.00	768.	54.00	818.	0.0	868.	17.98	918.	32.00	968.	0.0
519.	0.0	569.	39.72	619.	50.00	669.	53.00	719.	56.67	769.	54.00	819.	0.0	869.	17.00	919.	31.04	969.	0.0
520.	0.0	570.	40.00	620.	50.00	670.	52.33	720.	56.00	770.	54.00	820.	0.0	870.	16.34	920.	32.20	970.	0.0
521.	0.0	571.	40.00	621.	50.00	671.	52.00	721.	56.00	771.	54.00	821.	0.0	871.	15.00	921.	33.36	971.	0.0
522.	0.0	572.	40.00	622.	50.00	672.	52.33	722.	56.00	772.	54.00	822.	0.0	872.	15.00	922.	34.00	972.	0.0
523.	0.0	573.	40.00	623.	49.78	673.	52.91	723.	56.00	773.	54.00	823.	0.0	873.	15.00	923.	34.00	973.	0.0
524.	0.0	574.	40.00	624.	49.00	674.	52.25	724.	56.00	774.	53.01	824.	0.0	874.	15.96	924.	34.00	974.	0.0
525.	0.0	575.	40.00	625.	49.00	675.	53.00	725.	56.00	775.	50.86	825.	0.0	875.	16.35	925.	33.01	975.	0.0
526.	0.0	576.	40.82	626.	49.54	676.	53.00	726.	56.00	776.	49.70	826.	0.0	876.	15.28	926.	31.86	976.	0.0
527.	0.0	577.	41.00	627.	50.00	677.	53.00	727.	56.00	777.	48.54	827.	0.0	877.	14.27	927.	30.10	977.	0.0
528.	0.0	578.	41.00	628.	50.00	678.	53.00	728.	56.00	778.	47.39	828.	0.0	878.	12.59	928.	26.17	978.	0.0
529.	0.0	579.	41.33	629.	50.00	679.	53.00	729.	56.91	779.	46.23	829.	0.0	879.	12.25	929.	23.34	979.	0.0
530.	0.0	580.	42.00	630.	49.58	680.	53.00	730.	57.00	780.	45.07	830.	0.0	880.	9.28	930.	21.46	980.	0.51
531.	0.0	581.	42.00	631.	49.00	681.	53.00	731.	57.00	781.	43.91	831.	0.19	881.	8.00	931.	17.28	981.	0.33
532.	0.0	582.	42.00	632.	49.00	682.	53.00	732.	57.00	782.	42.51	832.	1.00	882.	8.00	932.	15.83	982.	0.0
533.	0.0	583.	42.93	633.	48.20	683.	53.00	733.	57.00	783.	40.60	833.	1.51	883.	8.38	933.	13.76	983.	0.0
534.	0.0	584.	43.00	634.	48.00	684.	53.00	734.	57.00	784.	39.44	834.	2.66	884.	9.53	934.	12.60	984.	0.0
535.	0.0	585.	43.00	635.	48.00	685.	53.00	735.	57.45	785.	38.28	835.	4.64	885.	10.69	935.	10.33	985.	0.0
536.	0.0	586.	43.00	636.	48.27	686.	55.00	736.	58.00	786.	37.13	836.	6.96	886.	11.00	936.	8.28	986.	0.0
537.	0.0	587.	43.56	637.	49.00	687.	55.00	737.	58.00	787.	35.94	837.	8.86	887.	9.00	937.	5.34	987.	0.0
538.	0.0	588.	44.71	638.	49.58	688.	55.00	738.	58.00	788.	33.81	838.	7.71	888.	9.00	938.	2.91	988.	0.0
539.	0.0	589.	45.00	639.	50.00	689.	55.00	739.	58.00	789.	32.66	839.	7.45	889.	9.32	939.	0.0	989.	0.0
540.	0.0	590.	44.97	640.	50.00	690.	55.00	740.	58.00	790.	30.50	840.	9.22	890.	10.00	940.	0.0	990.	0.0
541.	0.0	591.	44.14	641.	50.00	691.	55.00	741.	58.00	791.	28.34	841.	10.00	891.	9.36	941.	0.0	991.	0.0
542.	0.0	592.	44.66	642.	50.00	692.	55.00	742.	58.00	792.	26.37	842.	9.08	892.	9.00	942.	0.0	992.	0.0
543.	0.0	593.	44.00	643.	50.00	693.	55.00	743.	58.00	793.	25.03	843.	10.08	893.	9.95	943.	0.0	993.	0.0
544.	2.35	594.	44.00	644.	50.00	694.	55.00	744.	58.00	794.	21.87	844.	11.24	894.	14.33	944.	0.0	994.	0.0
545.	3.96	595.	44.81	645.	50.00	695.	55.00	745.	57.15	795.	19.85	845.	12.79	895.	17.53	945.	0.0	995.	0.0
546.	5.41	596.	45.00	646.	50.00	696.	55.00	746.	55.00	796.	16.56	846.	14.00	896.	19.42	946.	0.0	996.	0.0
547.	8.25	597.	45.00	647.	50.00	697.	55.00	747.	56.00	797.	15.40	847.	12.58	897.	20.00	947.	0.0	997.	0.0
548.	9.46	598.	45.00	648.	50.00	698.	55.00	748.	56.00	798.	14.24	848.	12.87	898.	20.74	948.	0.0	998.	0.0
549.	11.15	599.	45.44	649.	50.00	699.	55.00	749.	56.00	799.	12.17	849.	13.00	899.	21.00	949.	0.0	999.	0.0

Chassis Cycle (Gasoline and Diesel)

RECORD (SEC)	SPEED (MPH)	RECORD (SEC)	SPEED (MPH)
1000.	0.0	1050.	0.0
1001.	0.0	1051.	0.0
1002.	0.0	1052.	0.0
1003.	0.13	1053.	0.0
1004.	0.71	1054.	0.0
1005.	0.0	1055.	0.0
1006.	0.0	1056.	0.0
1007.	0.0	1057.	0.0
1008.	0.0	1058.	0.0
1009.	4.15	1059.	0.0
1010.	6.00	1060.	0.0
1011.	6.00		
1012.	6.00		
1013.	5.38		
1014.	4.14		
1015.	1.95		
1016.	0.0		
1017.	0.0		
1018.	0.0		
1019.	0.0		
1020.	0.0		
1021.	0.0		
1022.	0.0		
1023.	0.0		
1024.	0.0		
1025.	0.0		
1026.	0.0		
1027.	0.0		
1028.	0.0		
1029.	0.0		
1030.	0.0		
1031.	0.0		
1032.	0.0		
1033.	0.0		
1034.	0.0		
1035.	0.0		
1036.	0.0		
1037.	0.43		
1038.	1.64		
1039.	0.41		
1040.	0.0		
1041.	0.0		
1042.	0.0		
1043.	0.0		
1044.	0.0		
1045.	0.0		
1046.	0.0		
1047.	0.0		
1048.	0.0		
1049.	0.0		